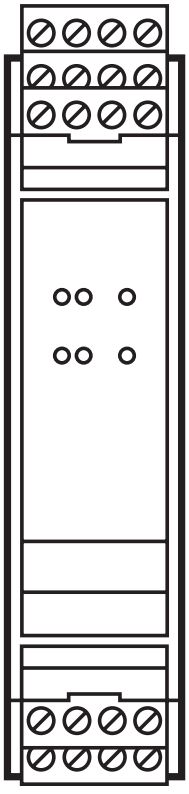
ifm electronic

CE

Original operating instructions
Safety relay with relay outputs
efectorno®
G1501S

UK



704064B1 / 04 01 / 2010

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1 Preliminary note

The instructions are part of the unit. They are intended for authorised persons according to the EMC and Low Voltage Directive and safety regulations.
The instructions contain information about the correct handling of the product.
Read the instructions before use to familiarise yourself with operating conditions, installation and operation.
Adhere to the safety instructions.

1.1 Symbols used

- ▶ Instructions
- > Reaction, result
- → Cross-reference
- ○ LED off
- ● LED on
- ✱ LED flashes
- ✱ LED flashes quickly

Important note
Non-compliance can result in malfunction or interference.

Information
Supplementary note.

2 Safety instructions

- Follow the operating instructions.
- Improper use may result in malfunctions of the unit. This can lead to personal injury and/or damage to property during operation of the machine. For this reason note all remarks on installation and handling given in these instructions. Also adhere to the safety instructions for the operation of the whole installation.
- In case of non-observance of notes or standards, specially when tampering with and/or modifying the unit, any liability and warranty is excluded.
- The unit must be installed, connected and put into operation by a qualified electrician trained in safety technology.
- The applicable technical standards for the corresponding application must be complied with.
- For installation the requirements according to EN 60204 must be observed.

- In case of malfunction of the unit please contact the manufacturer. Tampering with the unit is not allowed.
- Disconnect the unit externally before handling it. Also disconnect any independently supplied relay load circuits.
- After setup the system has to be subjected to a complete function check.
- Only use the unit under the specified operating conditions (→ 10 Technical data). In case of special operating conditions please contact the manufacturer.
- Use only as described below (→ 4).

3 Items supplied

- 1 G1501S safety relay including 5 Combicon connectors with screw terminals
- 1 copy of the operating instructions safety relay, reference 704064.

If one of the above-mentioned components is missing or damaged, please contact one of the ifm branch offices.

4 Functions and features

The safety relay is a redundant system and suited for use as:

- Safety relay for fail-safe sensors/switches with 2 PNP outputs (e.g. GM701S).
- Safety relay for clocked fail-safe sensors (e.g. GM504S)
- Two-hand control to EN 574, type IIIC, with electronic sensors/switches
- Two-hand control to EN 574, type IIIC with mechanical switches / safety relay for mechanical switches or 2-channel fail-safe sensors/switches (e.g. ESPE to EN 61496-1) with contact output with simultaneity monitoring
- Safety relay for mechanical switches or 2-channel fail-safe sensors/switches (e.g. non-contact safety devices EN 61496-1) with contact output and without simultaneity monitoring (indefinite simultaneity)

The safe state is when the output contacts (13-14 or 23-24) are open.

ifm electronic gmbh assumes no liability for the use of units made by external manufacturers.

Suitability of the product for a certain application cannot be assured and must be ensured by the user.

The safety relay conforms to the category 4 according to EN 954-1 (valid until 31 December 2011), Performance Level e according to EN ISO 13849-1: 2008 as well as to the requirements SIL 3 to IEC 61508 and the classification type IIIC according to EN 574.

4.1 Requirements for the hardware configuration

The following requirements must be complied with when using the safety relay G1501S:

4.1.1 Product-independent requirements

It must be ensured that the safety requirements of the respective application correspond to the requirements stated in these instructions.
The specified technical data indicated in these instructions must be complied with.
The principle of normally closed operation must be applied to all external safety circuits connected to the system.

By taking administrative measures in the application it must be ensured that

- the safety relays type G1501S in operation are subjected to a self-test (switching off) within a period of maximum 12 months (intermittent operation)
- the safety-related relay contacts are protected using a suitable fuse of 3.6 A as short-circuit / overload protection.

The self-test can be carried out by switching the supply voltage off and on or by a safety request.

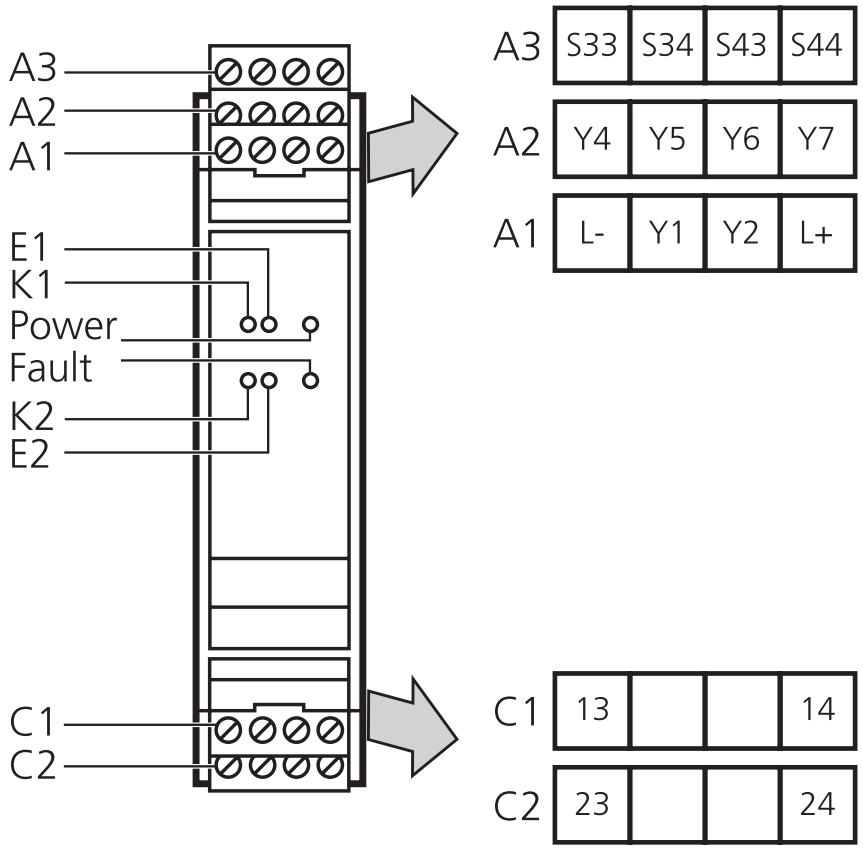
4.1.2 Product-dependent requirements

In case of faults within the safety relay which result in the defined safe state, the safety relay must be replaced.

Any faulty unit should be returned to the manufacturer.

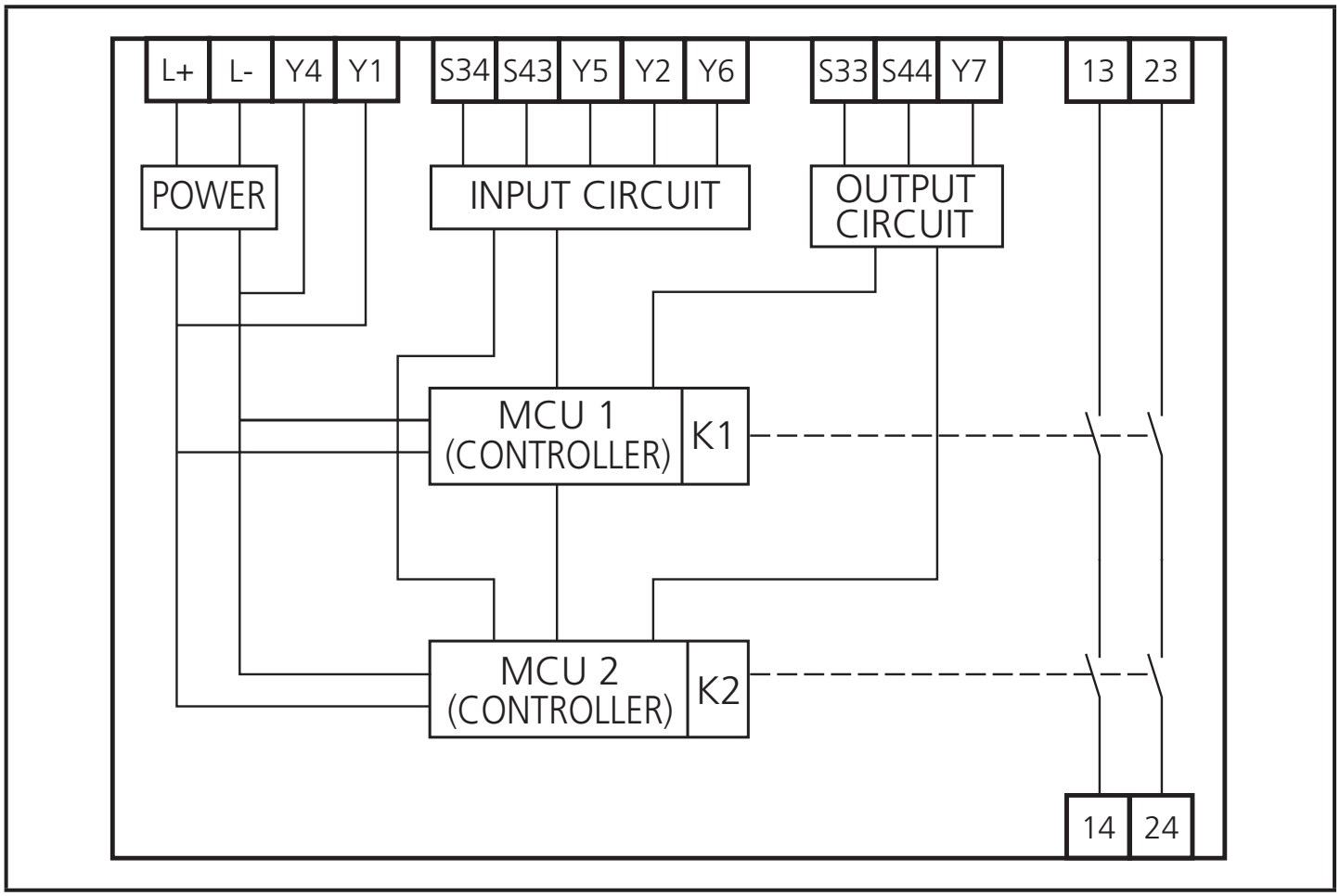
5 Structure and operating principle

5.1 Indicators and connections



A1	Supply voltage (L-, L+), function terminals (Y1, Y2)
A2	Y4, Y5, Y6, Y7: Operating mode selection, auxiliary output
A3	S33, S34, S43, S44: Connection for safety inputs / outputs
K 1	LED yellow: Triggering of the relay output channel 1
K 2	LED yellow: Triggering of the relay output channel 2
E 1	LED yellow: Input signal channel 1 or TE (for clocked sensor)
E 2	LED yellow: Input signal channel 2 or A (for clocked sensor)
Power	LED green: Voltage supply
Fault	LED red: Fault/start-up
C1	13, 14: Connection of relay output without delay, 1 x normally open (closed when enabled)
C2	23, 24: Connection of relay output, 1 x normally open (closed when enabled)

5.2 Block diagram



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6 Installation

▶ Mount the unit on a DIN rail in a housing protected against dust and humidity (min. IP54 - degree of soiling 2).

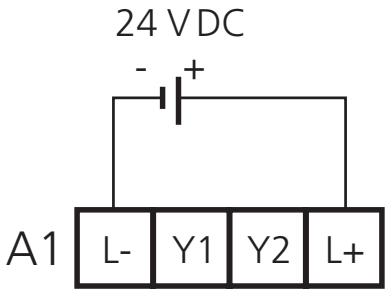
7 Electrical connection

▶ Use 60/75°C copper conductors only.

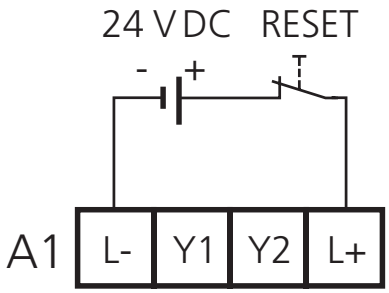
7.1 Supply voltage

The external supply unit must have a safe separation. In case of a fault the voltage can exceed the value of 60 V DC for a maximum of 200 ms, but must not exceed the value of 120 V DC.

▶ **Connect supply voltage**



Manual reset

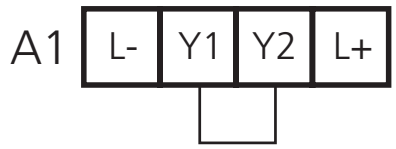


For safety reasons the unit can only be restarted by separation from the supply voltage in case of a fault. It is thus recommended to install a RESET switch in series with the L+ circuit.

After power on or a RESET the unit carries out self diagnostic functions. After this self diagnosis the unit is ready for operation.

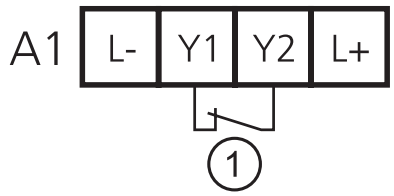
7.2 Feedback contacts / monitored or automatic start

Automatic start



Automatic activation without monitoring.

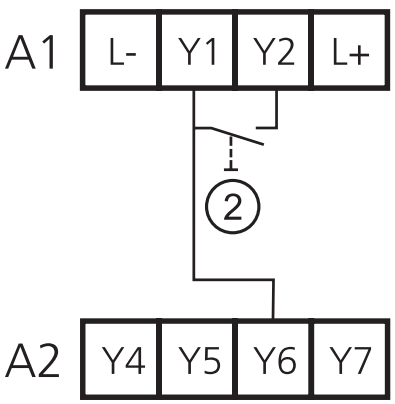
Monitoring of the feedback contacts (normally closed) for automatic start



The circuit is enabled when the feedback contacts are closed.
Consider the current flowing through the feedback contacts (→ 10 Technical data).

1: Feedback contact

Monitored start

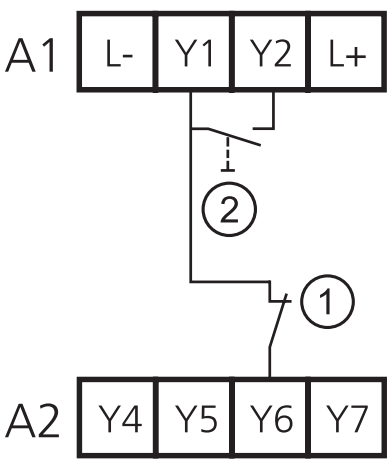


Activate the relay outputs:
▶ Press and release the start button (> 50 ms).

This function is not active when used as two-hand control.

2: Start button

Monitoring of the feedback contacts (normally closed) for monitored start



Activate the relay outputs:
Feedback contacts are closed
▶ Press and release the start button (> 50 ms).

This function is not active when used as two-hand control.

Consider the current flowing through the feedback contacts (→ 10 Technical data).

1: Feedback contact
2: Start button

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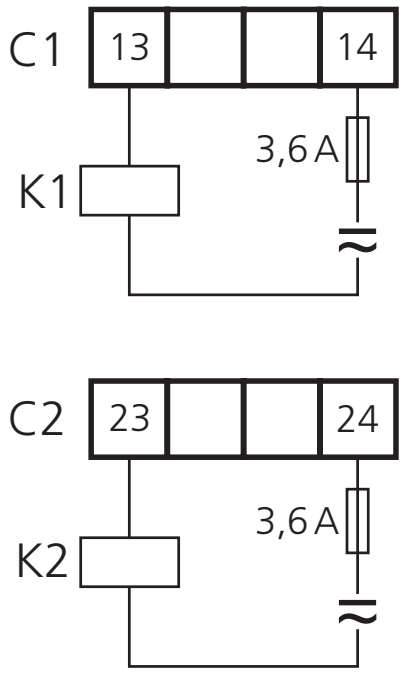
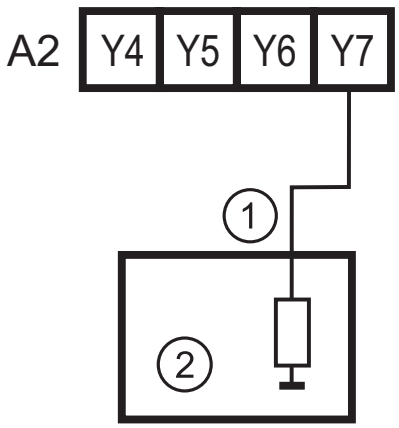
7.3 Output circuit

Connect the load



Connect the load to be controlled to the outputs C1 (13-14) or C2 (23-24).

Adhere to the maximum and minimum load conditions (→ 10 Technical data).



Output Y7 provides a non-safety related signal for communication to a plc. The signal corresponds to that triggering the relays at the outputs 13/14 and 23/24. The output data is compatible with the input data of the current-sinking inputs of type 1, 2, 3 to EN 61131-2.

1: Input
2: PLC

8 Connection - Function - Fault diagnosis

The safety relay can be connected or used in different ways:

1. Safety relay for fail-safe sensors/switches with 2 PNP outputs (e.g. GM701S).
2. Safety relay for clocked fail-safe sensors (e.g. GM504S)
3. Two-hand control to EN 574, type IIIC, with electronic sensors/switches
4. Two-hand control to EN 574, type IIIC with mechanical switches / safety relay for mechanical switches or 2-channel fail-safe sensors/switches (e.g. ESPE to EN 61496-1) with contact output with simultaneity monitoring
5. Safety relay for mechanical switches or 2-channel fail-safe sensors/switches (e.g. non-contact safety devices EN 61496-1) with contact output and without simultaneity monitoring (indefinite simultaneity)

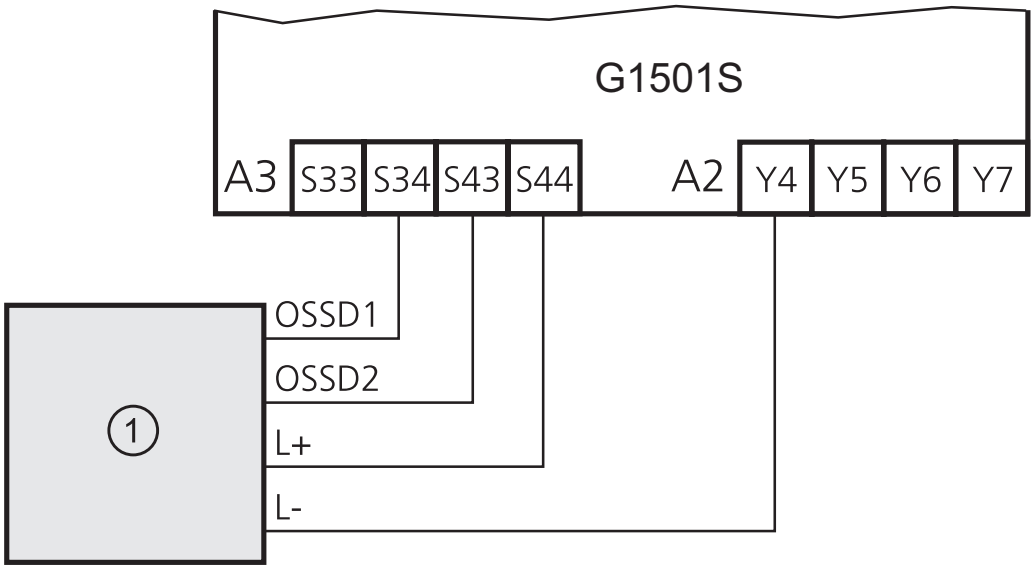
8.1 Safety relay for fail-safe sensors/switches with 2 PNP outputs

Example of fail-safe sensors/switches:

- Fail-safe inductive sensor GM701S
- Light barrier
- Light curtain (ESPE to EN 61496-1)
- Laser scanner

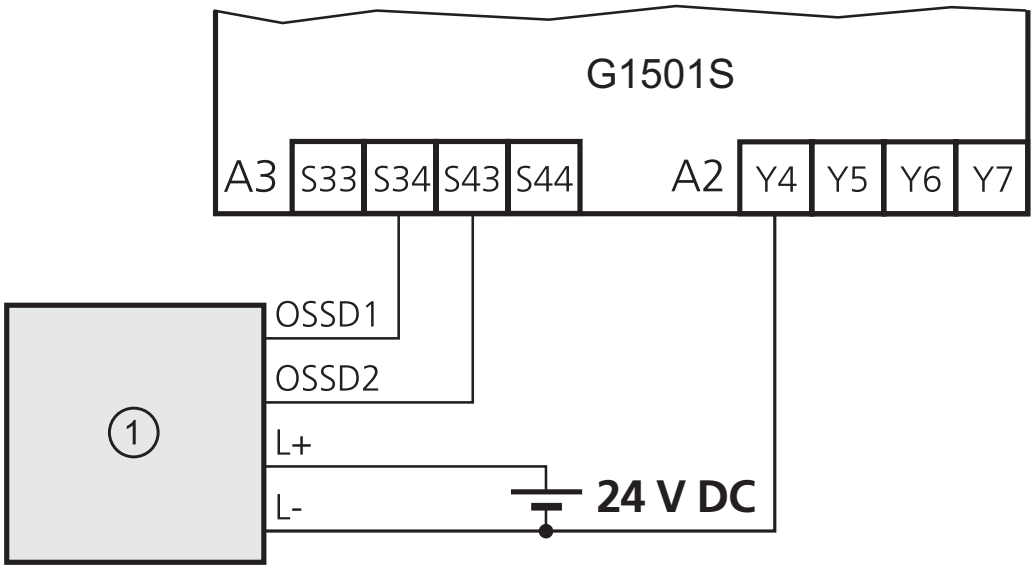
8.1.1 Connection

Fail-safe sensor/switch with a current consumption of ≤ 50 mA:



1: Fail-safe sensor/switch

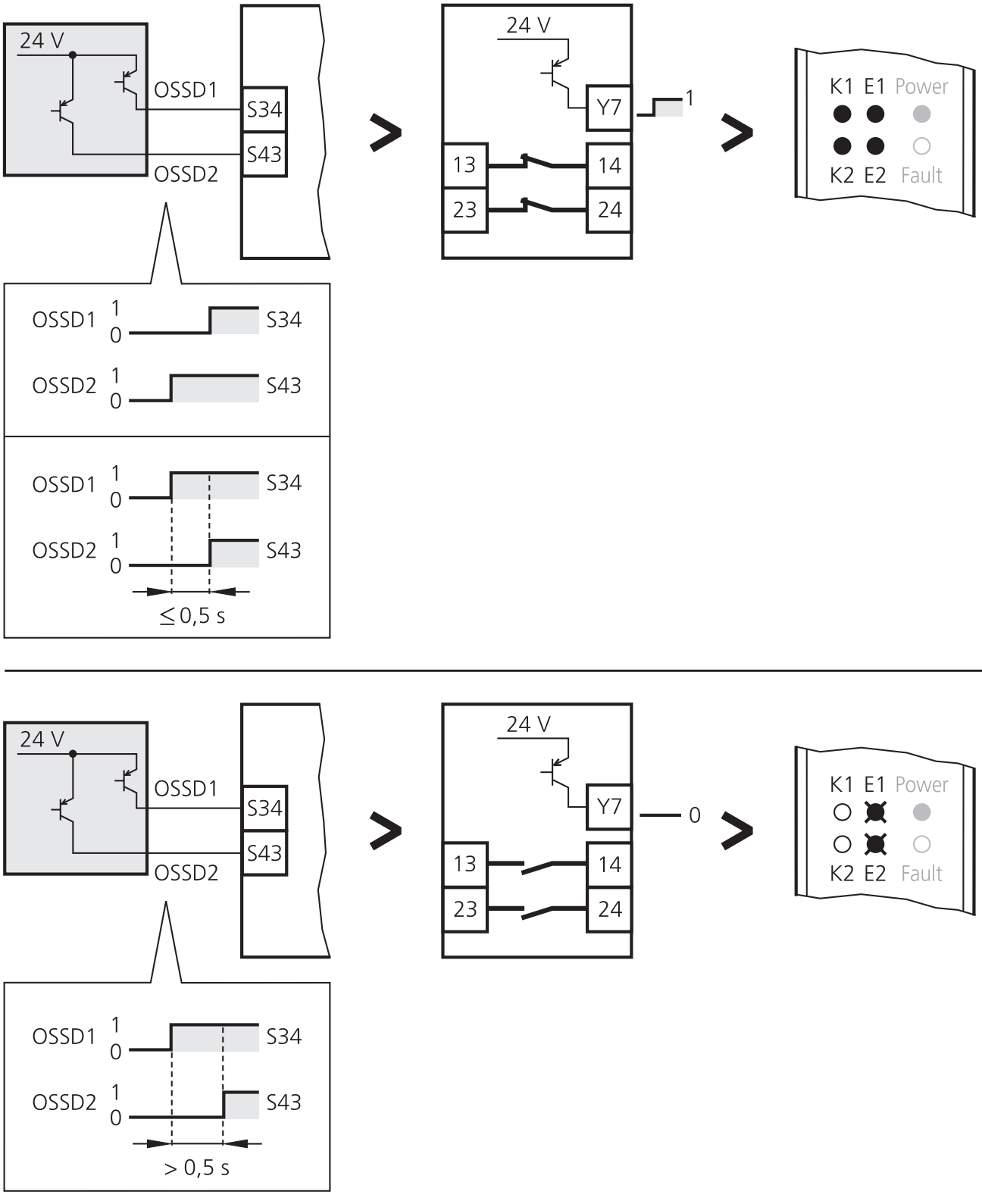
Fail-safe sensor/switch with a current consumption of > 50 mA:



1: Fail-safe sensor/switch

8.1.2 Function

Input circuit	Output status	LED display



Stop flashing:

▶ Activate inputs in correct time sequence (→ fig. above)

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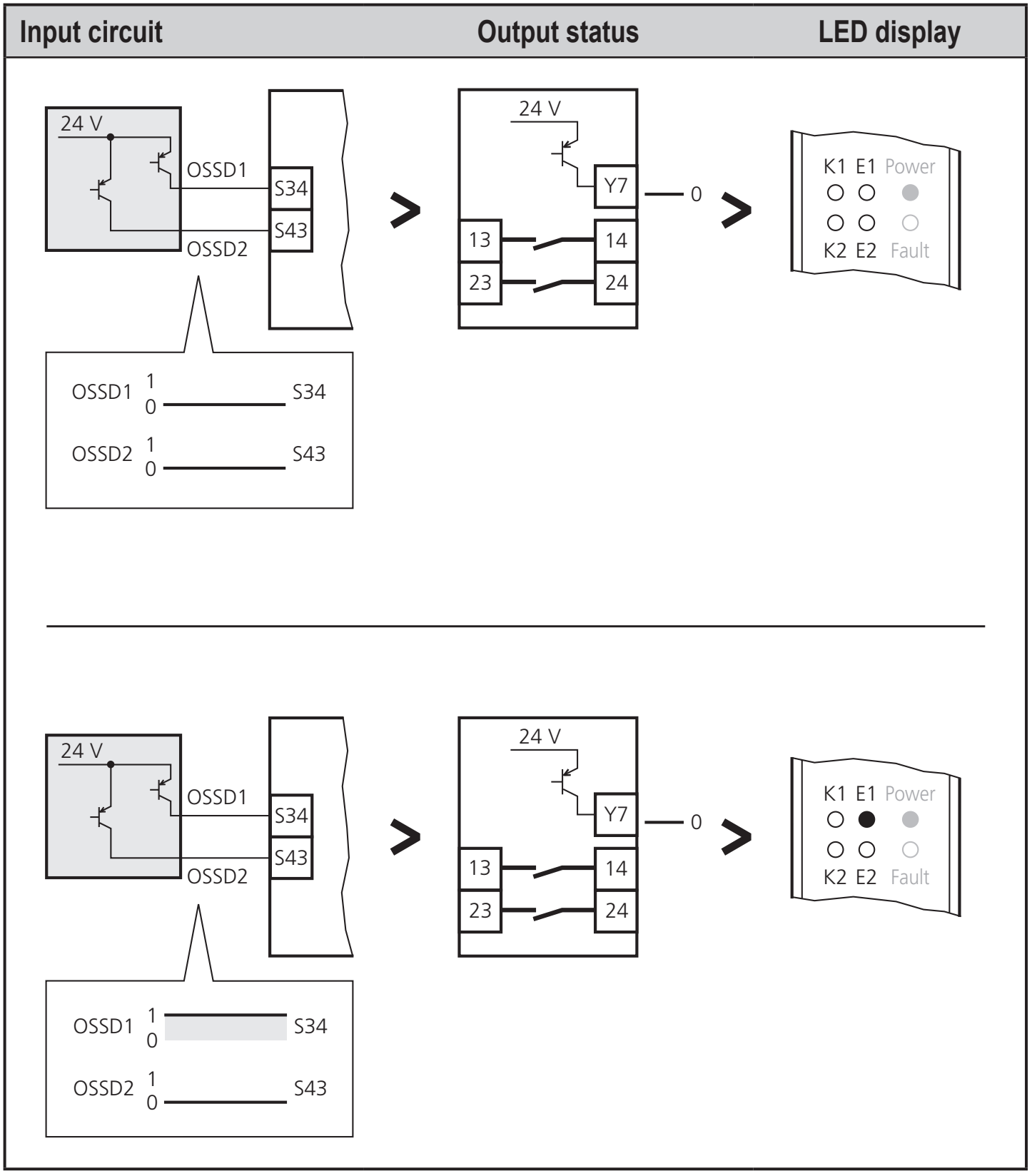
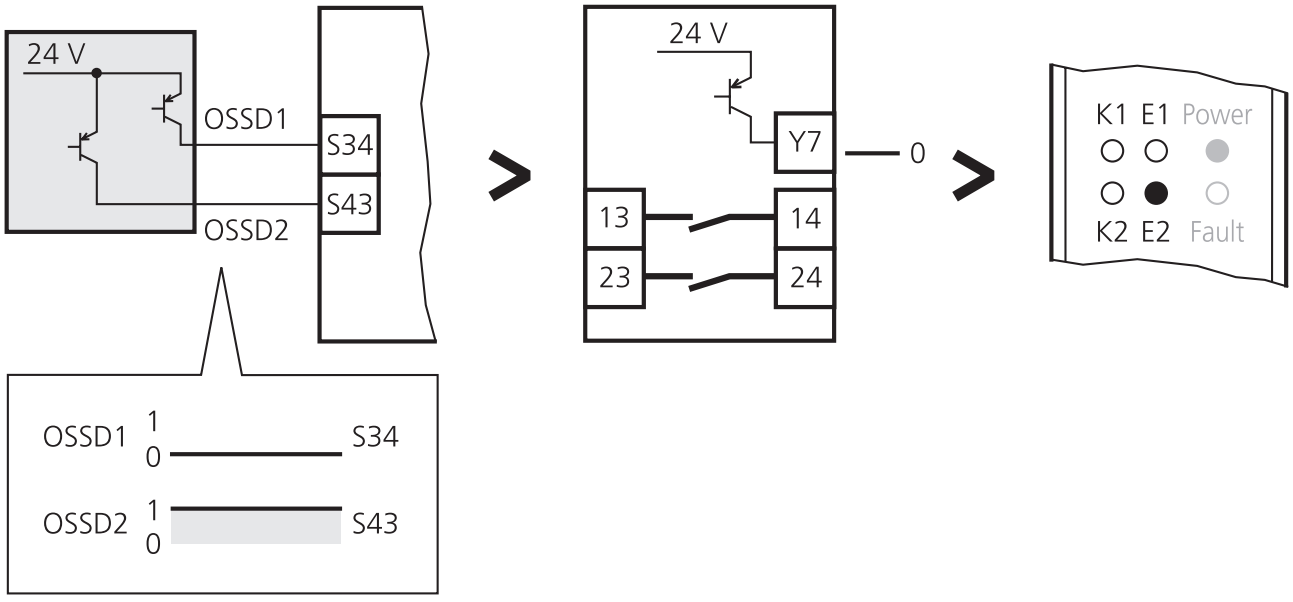
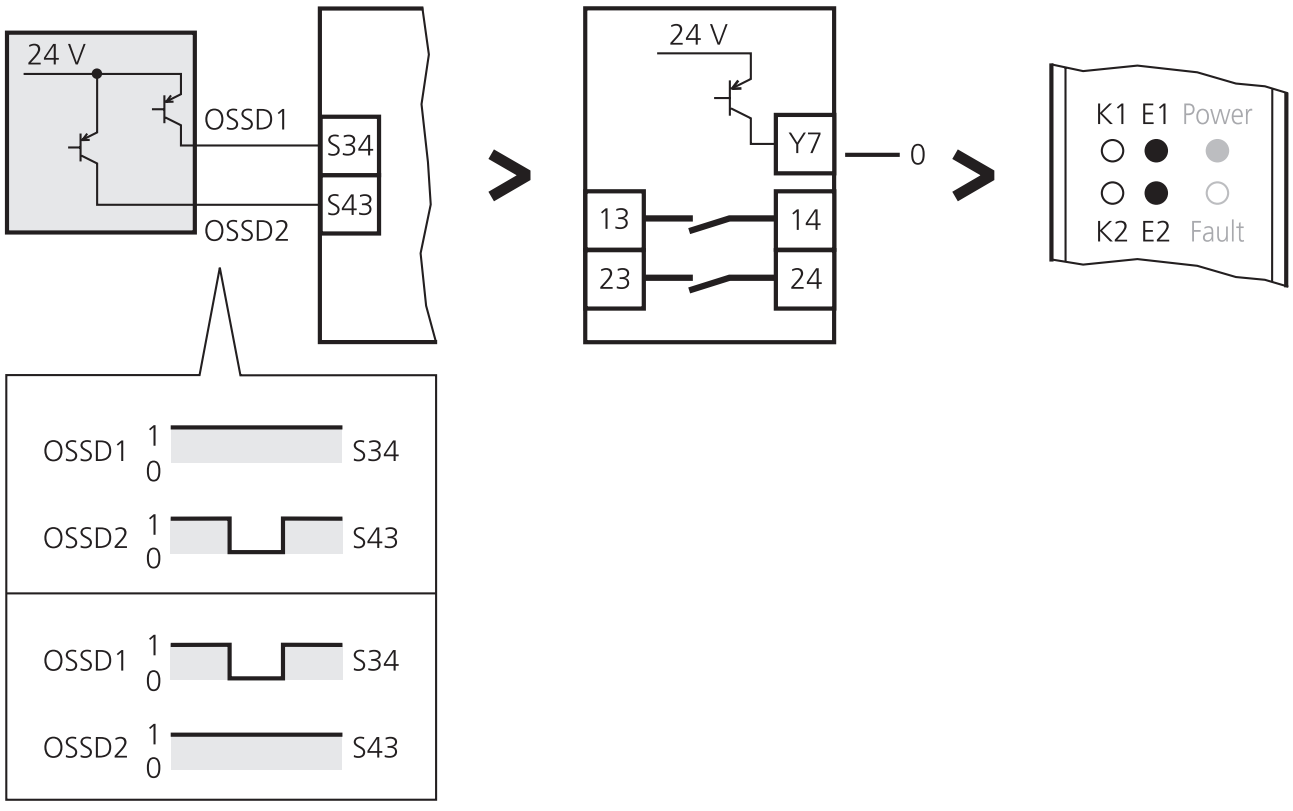

Input circuit
Output status
LED display
24 V
OSSD1
OSSD2
S34
S43
OSSD1 1 0 S34
OSSD2 1 0 S43
24 V
Y7
0
13
14
23
24
K1 E1 Power
K2 E2 Fault
24 V
OSSD1
OSSD2
S34
S43
OSSD1 1 0 S34
OSSD2 1 0 S43
24 V
Y7
0
13
14
23
24
K1 E1 Power
K2 E2 Fault

Input circuit	Output status	LED display





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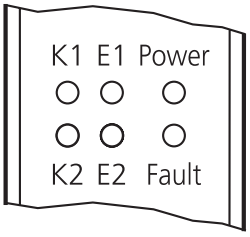
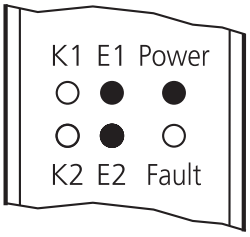
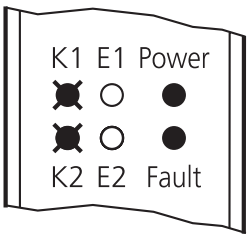
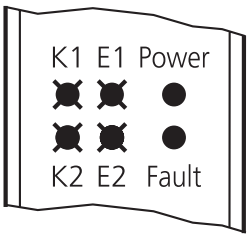
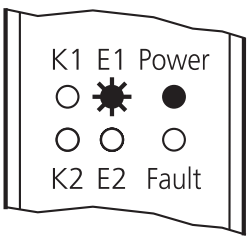
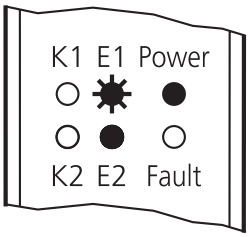
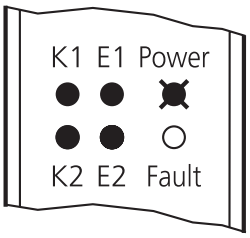
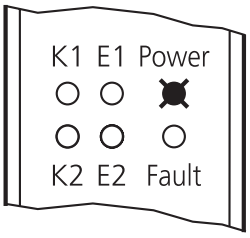
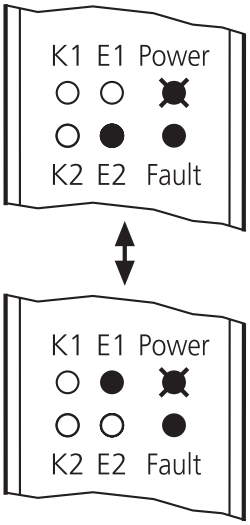
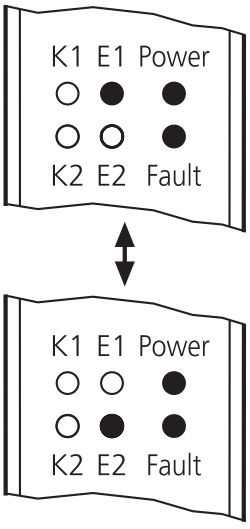
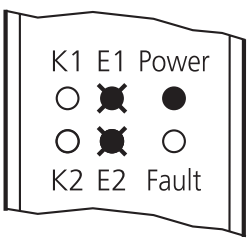
8.1.3 Fault diagnosis

In case of a fault switch the safety relay off and on again!

LED display	Cause of the fault	Troubleshooting
	• No voltage supply • Overvoltage • Connection A1/A3 or A1/A2 reversed	▶ Check wiring ▶ Check power supply
	• Wire break • Feedback contacts open	▶ Check wiring ▶ Switch the safety relay off and on again
	• When voltage is applied: Feedback contacts open	▶ Check output circuit ▶ Check feedback contacts ▶ Exchange external contactor
	• Wiring fault • Short circuit • Inputs S34 and S43 “1” when voltage is applied	▶ Check wiring ▶ Switch the fail-safe sensor/ switch off and on again
	• Short circuit S33/S43	▶ Check wiring
	• Short circuit S33/S43	▶ Check wiring

LED display	Cause of the fault	Troubleshooting
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Undervoltage	▶ Check wiring ▶ Check power supply
	• Short circuits	▶ Check wiring
	• Input S43 active more than 0.5 s after input S34 (→ 8.1.2) • Feedback contact error • Short circuit S34/S44	▶ Check wiring ▶ Switch the fail-safe sensor/ switch off and on again

8.2 Safety relay for clocked fail-safe sensors

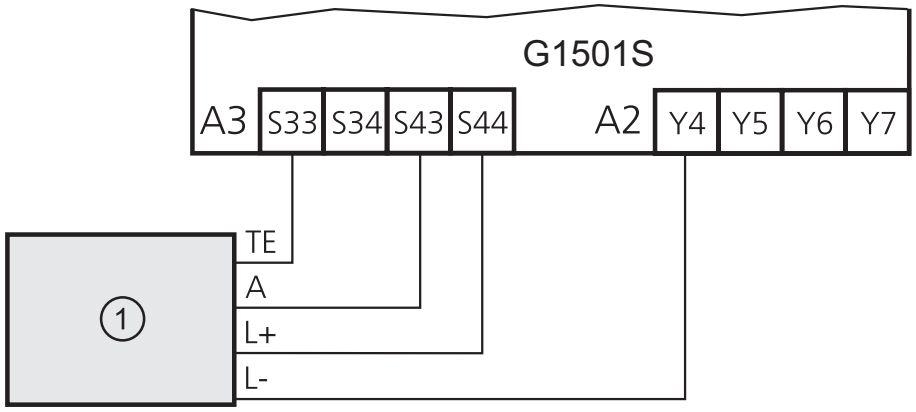
Example of fail-safe sensors/switches:

- Fail-safe inductive sensor GM504S

Up to 10 clocked fail-safe sensors can be connected to one safety relay.

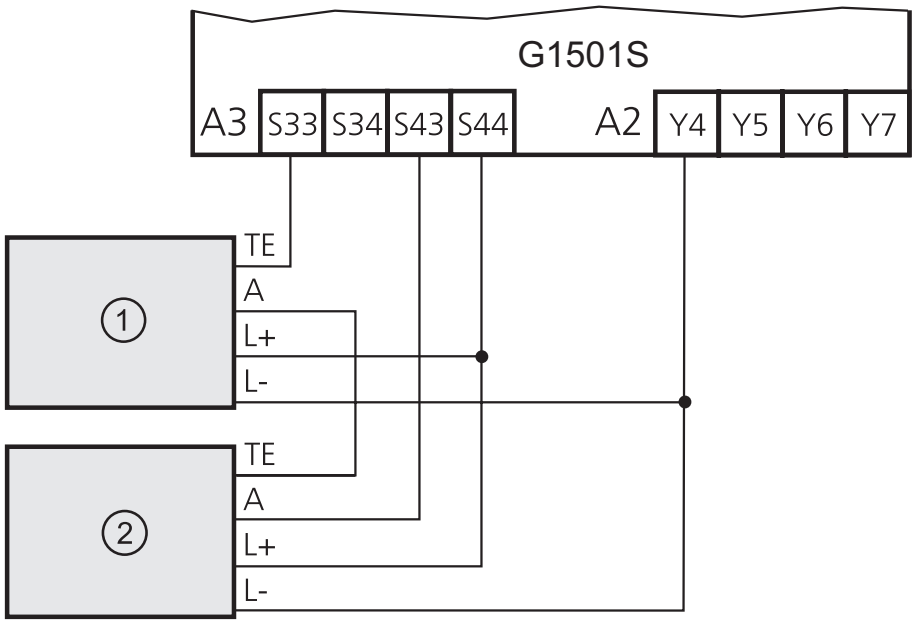
8.2.1 Connection

Connection of one fail-safe sensor/switch:



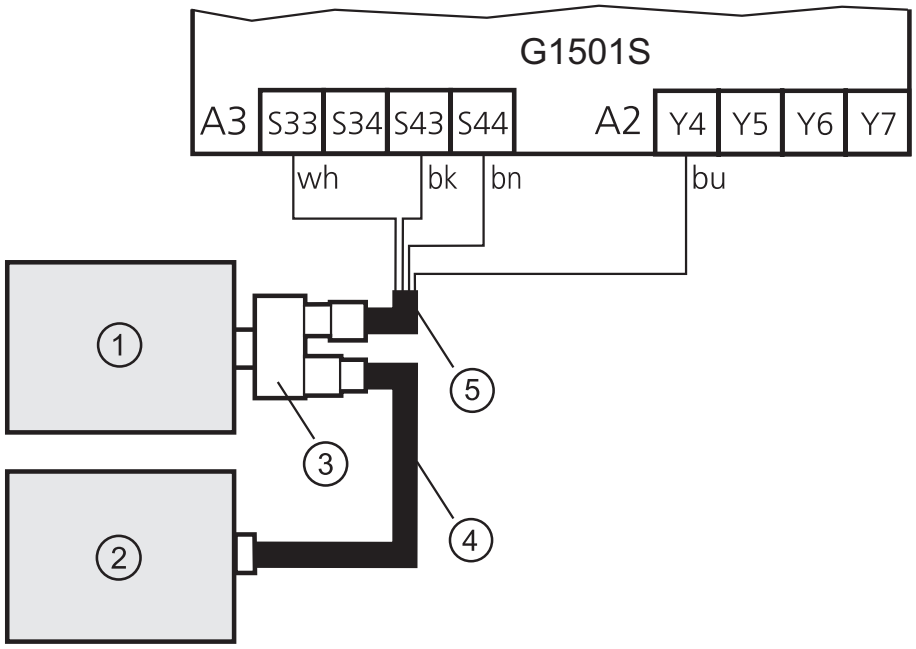
1: Fail-safe sensor/switch

Connection of 2 fail-safe sensors/switches:



1: Fail-safe sensor/switch 1 2: Fail-safe sensor/switch 2

The use of the safety splitter box E11569 is recommended:



1: Fail-safe sensor/switch 1
2: Fail-safe sensor/switch 2
3: E11569
4: e.g. E10884
5: e.g. E10662

wh = white
bk = black
bn = brown
bu = blue

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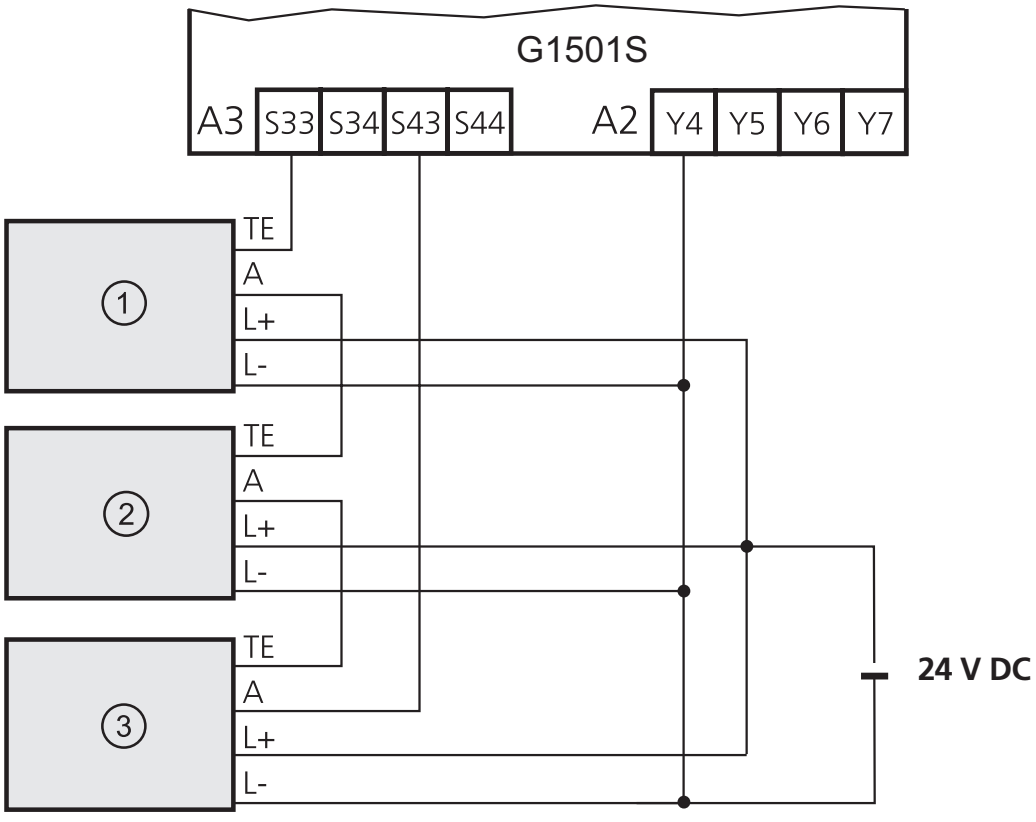
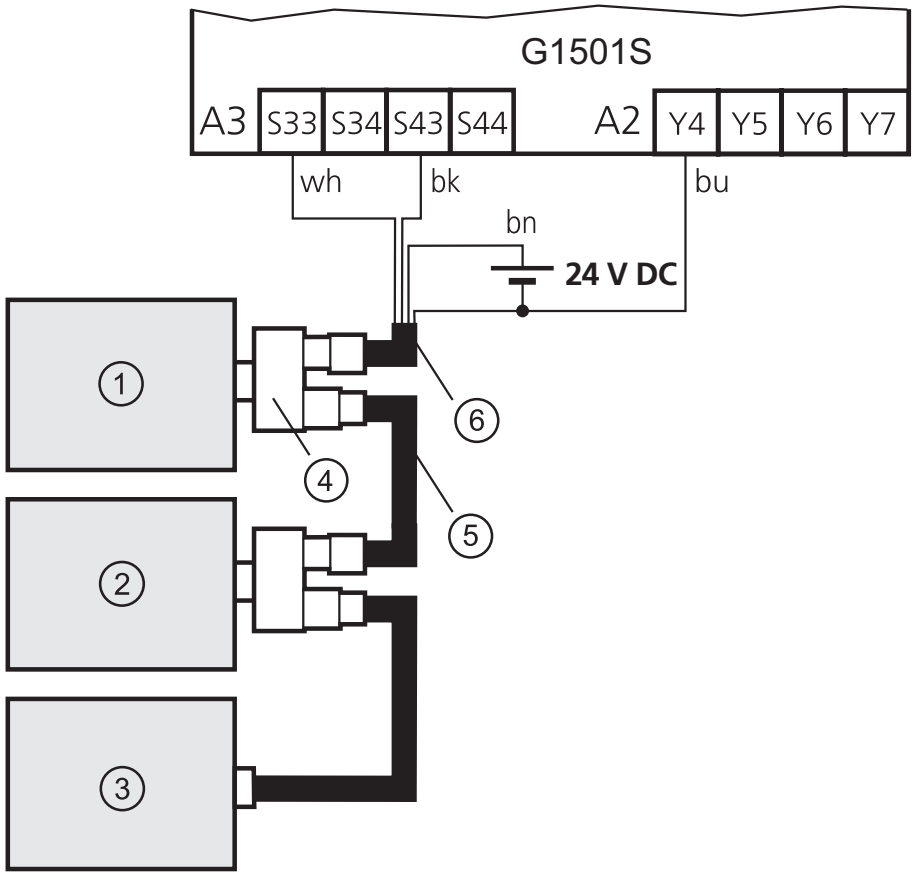
Connection of 3 to 10 fail-safe sensors/switches:



1: Fail-safe sensor/switch 1
2: Fail-safe sensor/switch 2
3: Fail-safe sensor/switch 3

The use of the safety splitter box E11569 is recommended:



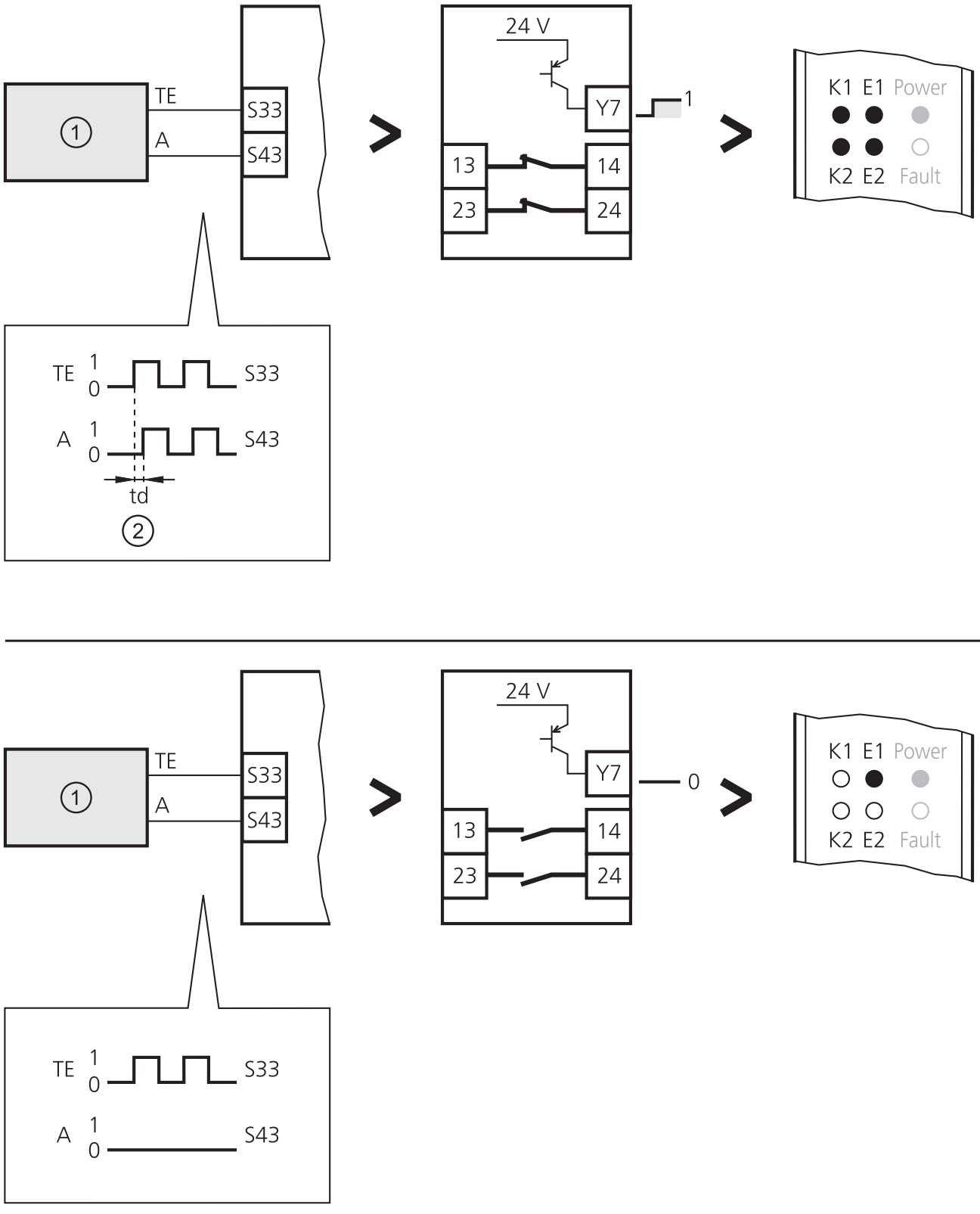
1: Fail-safe sensor/switch 1
2: Fail-safe sensor/switch 2
3: Fail-safe sensor/switch 3

4: E11569
5: e.g. E10884
6: e.g. E10662

wh = white
bk = black
bn = brown
bu = blue

8.2.2 Function

Input circuit	Output status	LED display

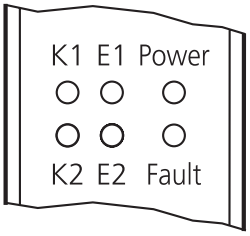
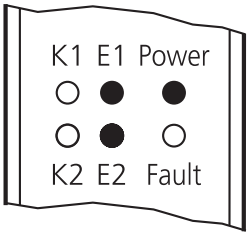
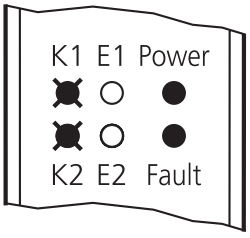
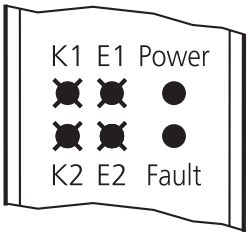
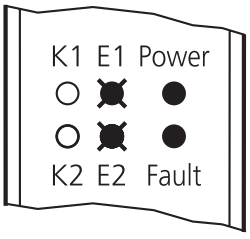
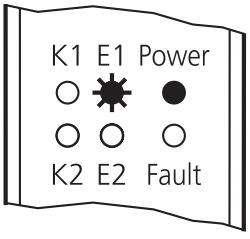


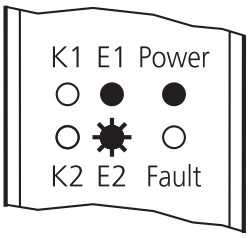
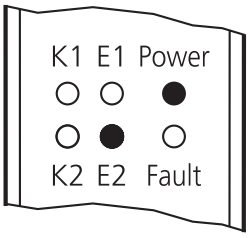
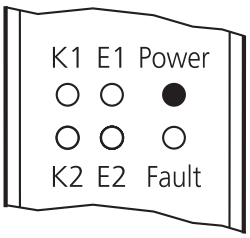
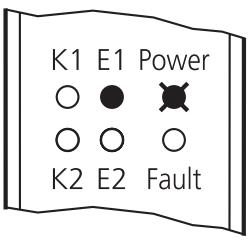
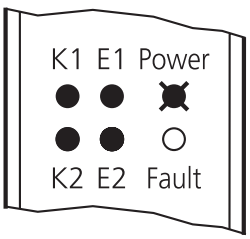
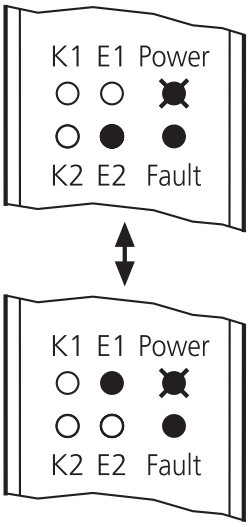
1: First or last fail-safe sensor/switch of a row of sensors/switches
2: td = max. 16 ms

UK

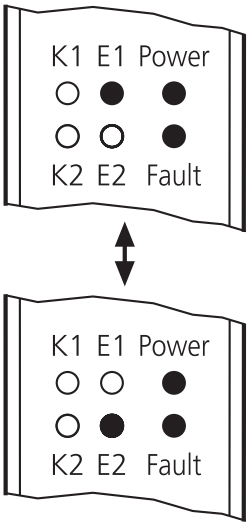
8.2.3 Fault diagnosis

In case of a fault switch the safety relay off and on again!

LED display	Cause of the fault	Troubleshooting
	• No voltage supply • Overvoltage • Connection A1/A2 reversed	▶ Check wiring ▶ Check power supply
	• Wire break • Feedback contacts open • Time-dependent contacts	▶ Check wiring ▶ Switch the safety relay off and on again
	• When voltage is applied: Feedback contacts open	▶ Check output circuit ▶ Check feedback contacts ▶ Exchange external contactor
	• Short circuit • Connection A1/A3 or A2/A3 reversed	▶ Check wiring
	• Short circuit S43/L+ or S44/L-	▶ Check wiring
	• Short-circuit S34/S44 or S33/S43	▶ Check wiring

LED display	Cause of the fault	Troubleshooting
	• Short circuit S34/L+	▶ Check wiring
	• Short circuit S43/L+ or S34/ S44	▶ Check wiring
	• Missing clock • Wiring fault • Connection A2/A3 reversed • Short circuit S43/L-	▶ Check wiring
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Undervoltage	▶ Check wiring ▶ Check power supply

UK

LED display	Cause of the fault	Troubleshooting
	• Short circuits	▶ Check wiring

8.3 Two-hand control using electronic sensors/switches

Example of electronic sensors/switches:

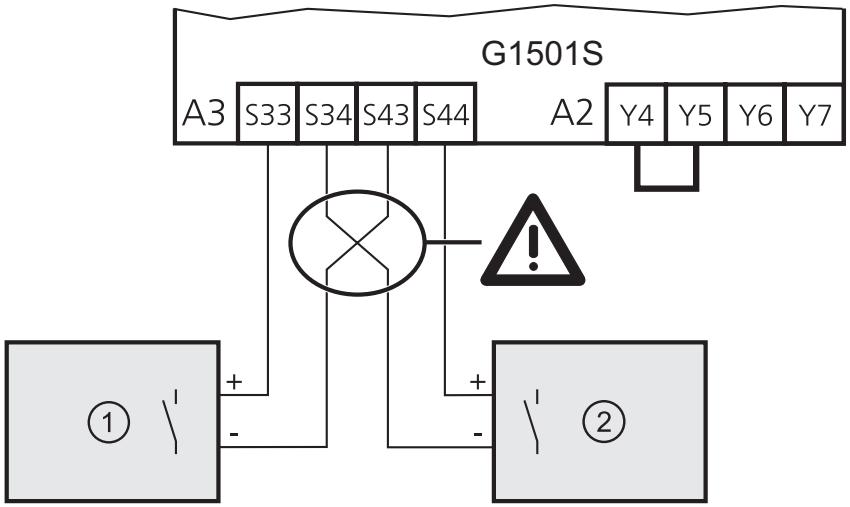
- Capacitive sensors

For product selection see www.ifm.com

This wiring meets the requirements type IIIB to EN 574. Use up to type IIIC is possible using corresponding sensors/switches with two independent switching elements, internal plausibility check and protected or screened wires.

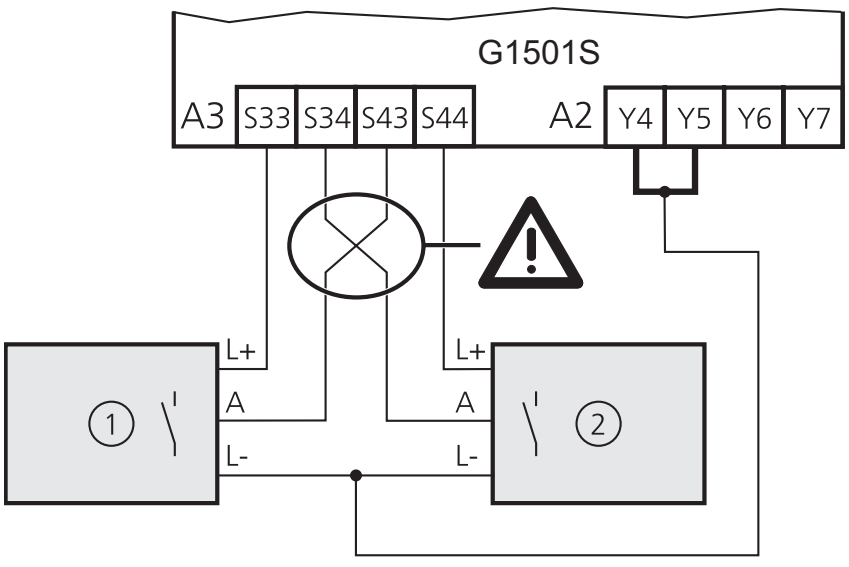
8.3.1 Connection

Connection of two 2-wire DC:



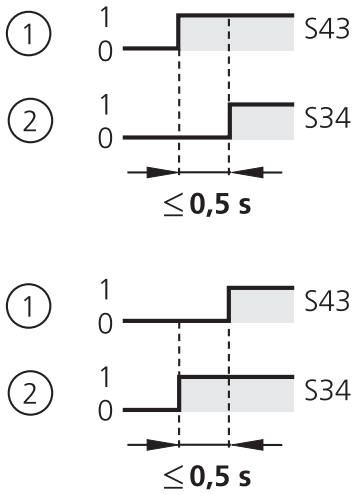
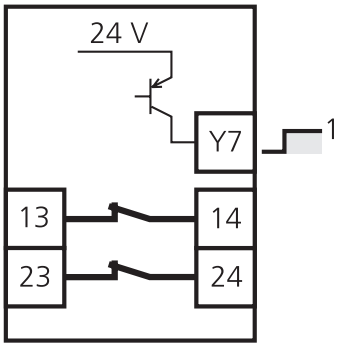
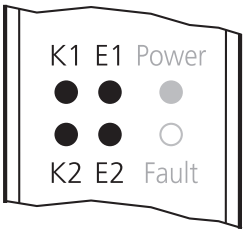
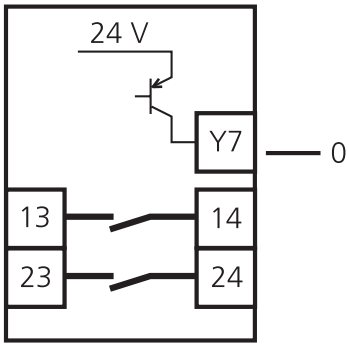
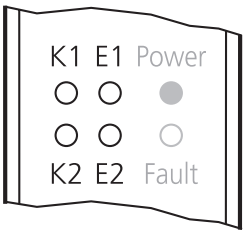
1: Electronic fail-safe sensor 1 2: Electronic fail-safe sensor 2

Connection of two 3-wire DC:



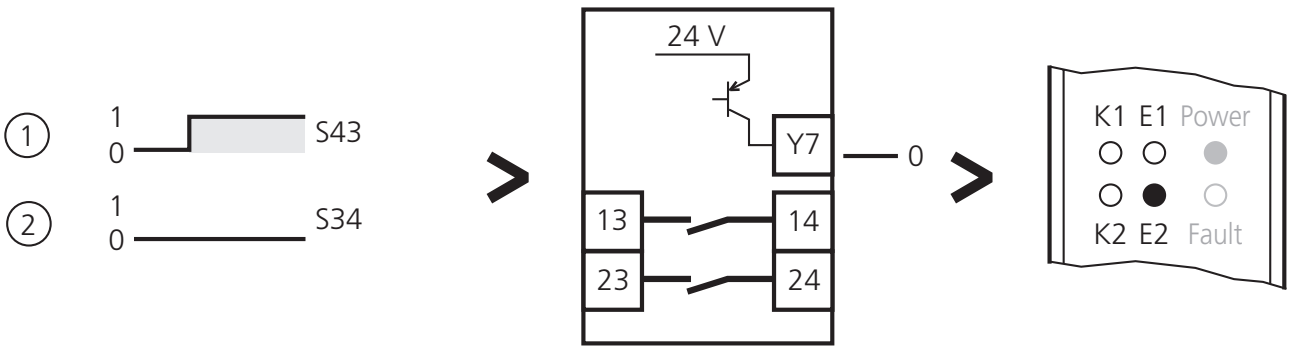
1: Electronic fail-safe sensor 1 2: Electronic fail-safe sensor 2

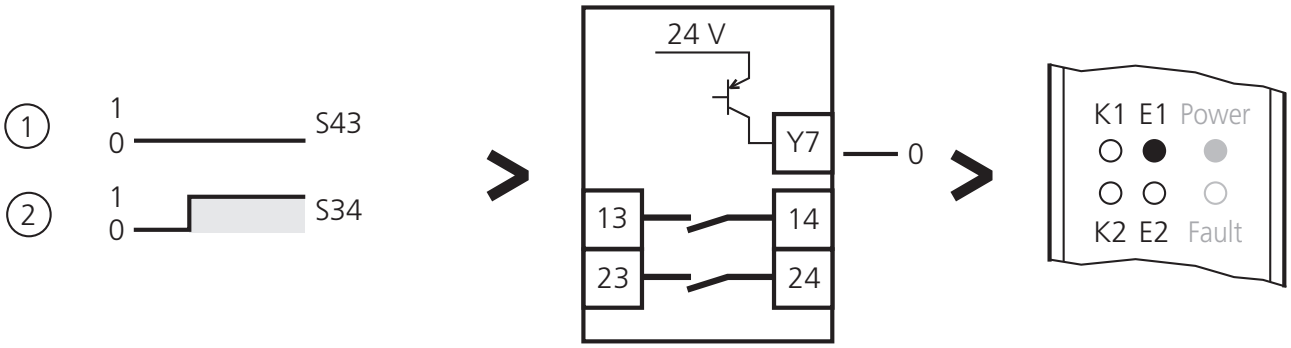
8.3.2 Function

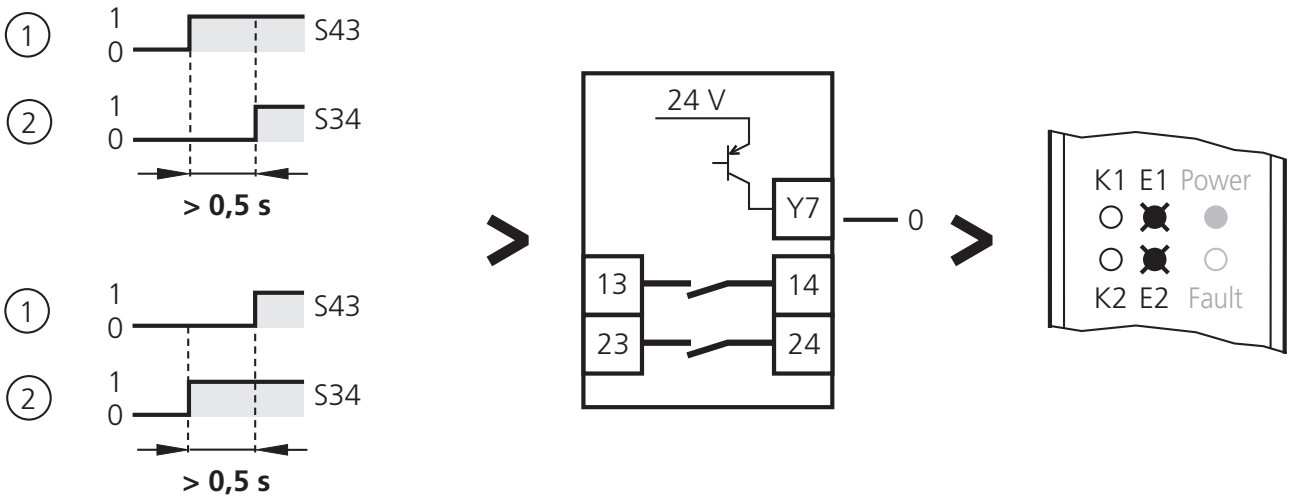
Input circuit	Output status	LED display
		
		

1: Electronic fail-safe sensor 1 2: Electronic fail-safe sensor 2

Input circuit	Output status	LED display





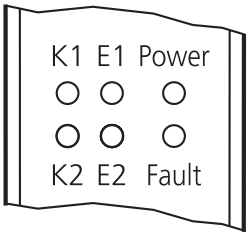
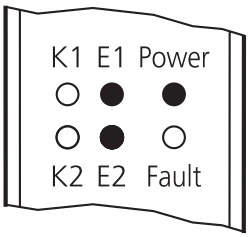
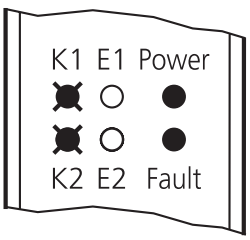
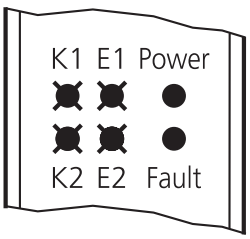
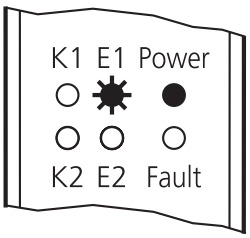
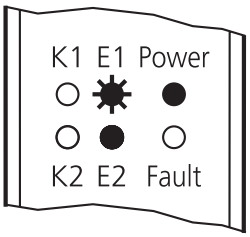


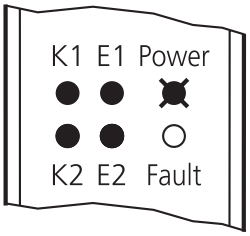
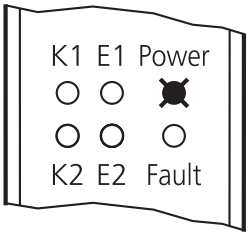
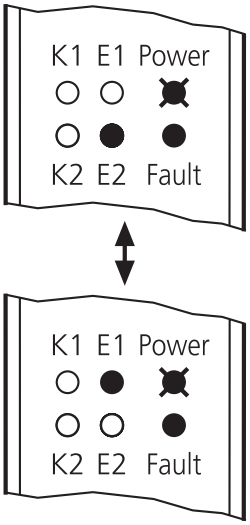
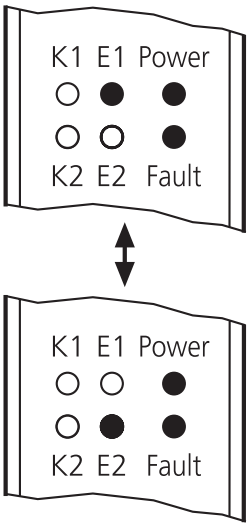
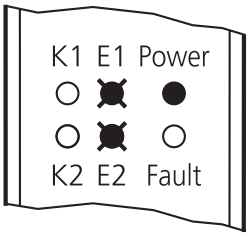
1: Electronic fail-safe sensor 1

2: Electronic fail-safe sensor 2

8.3.3 Fault diagnosis

In case of a fault switch the safety relay off and on again!

LED display	Cause of the fault	Troubleshooting
	• No voltage supply • Overvoltage • Connection A1/A3 or A1/A2 reversed	▶ Check wiring ▶ Check power supply
	• Wire break • Feedback contacts open • Time-dependent contacts	▶ Check wiring ▶ Switch the safety relay off and on again
	• When voltage is applied: Feedback contacts open	▶ Check output circuit ▶ Check feedback contacts ▶ Exchange external contactor
	• Wiring fault • Missing link Y4/Y5 • Short circuit • Inputs S34 and S43 activated when voltage is applied	▶ Check wiring ▶ Deactivate inputs and RESET or voltage failure
	• Connections A3/A2 reversed	▶ Check wiring
	• Missing link Y4/Y5	▶ Check wiring

LED display	Cause of the fault	Troubleshooting
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Undervoltage	▶ Check wiring ▶ Check power supply
	• Short circuits	▶ Check wiring
	• Inputs S34 and S43 not activated within 0.5 s (→ 8.3.2) • Feedback contact error • Short circuit S34/S44	▶ Check wiring ▶ Deactivate inputs and activate them again

8.4 Two-hand control using mechanical switches with simultaneity monitoring

Two-hand control with mechanical switches / safety relay for mechanical switches or 2-channel fail-safe sensors/switches with contact output with simultaneity monitoring.

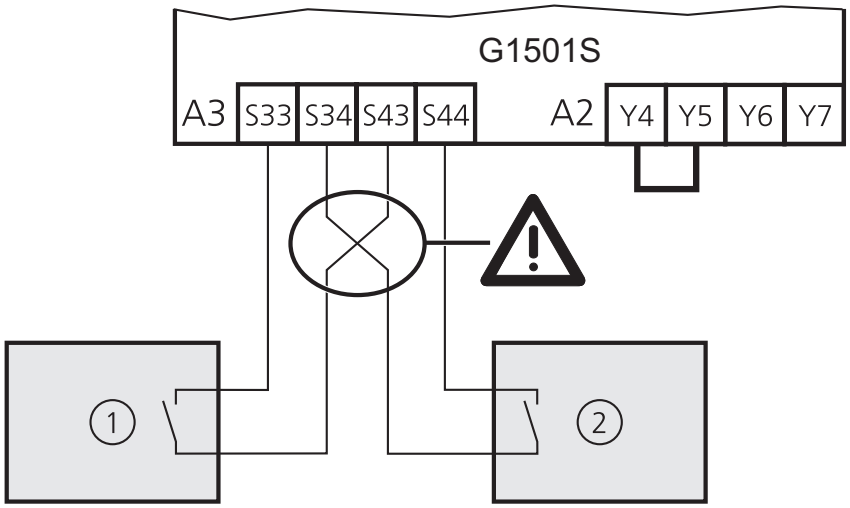
The contacts of the mechanical switches must allow a minimum current of 6 mA.

8.4.1 Connection

Connection of two mechanical fail-safe switches

This wiring (with only one normally open contact per sensor/switch) meets the requirements of type IIIB to EN 574.

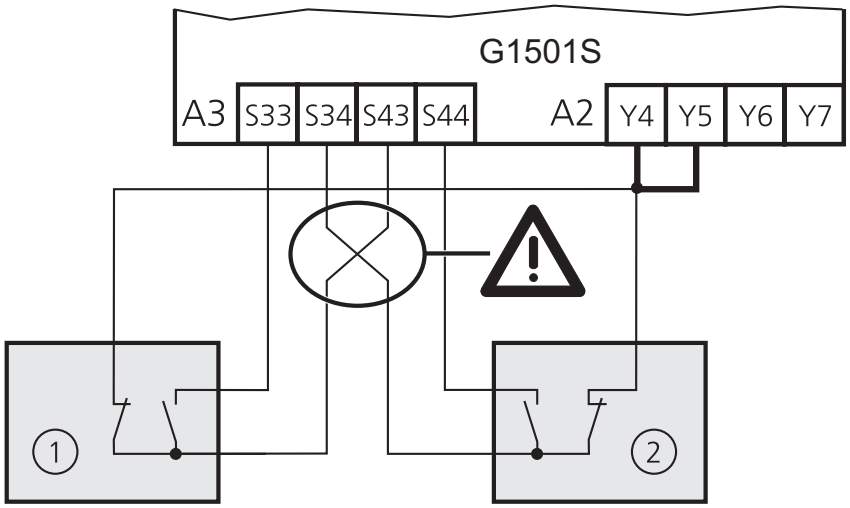
Use up to type IIIC is possible using corresponding sensors/switches approved to EN 60947-5-1 annex K and protected or screened wires.



1: Mechanical fail-safe switch 1

2: Mechanical fail-safe switch 2

Connection of mechanical switches according to type IIIC to EN 574

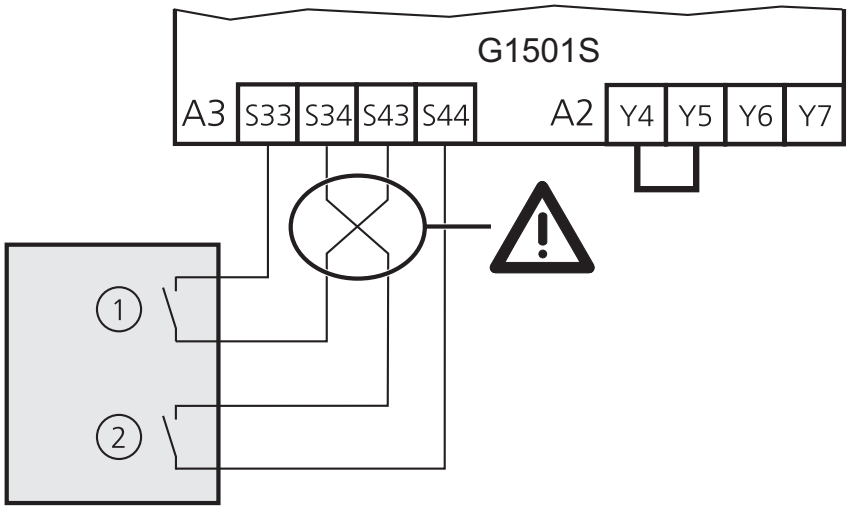


1: Mechanical switch 1 (no positively driven contacts)

2: Mechanical switch 2 (no positively driven contacts)

UK

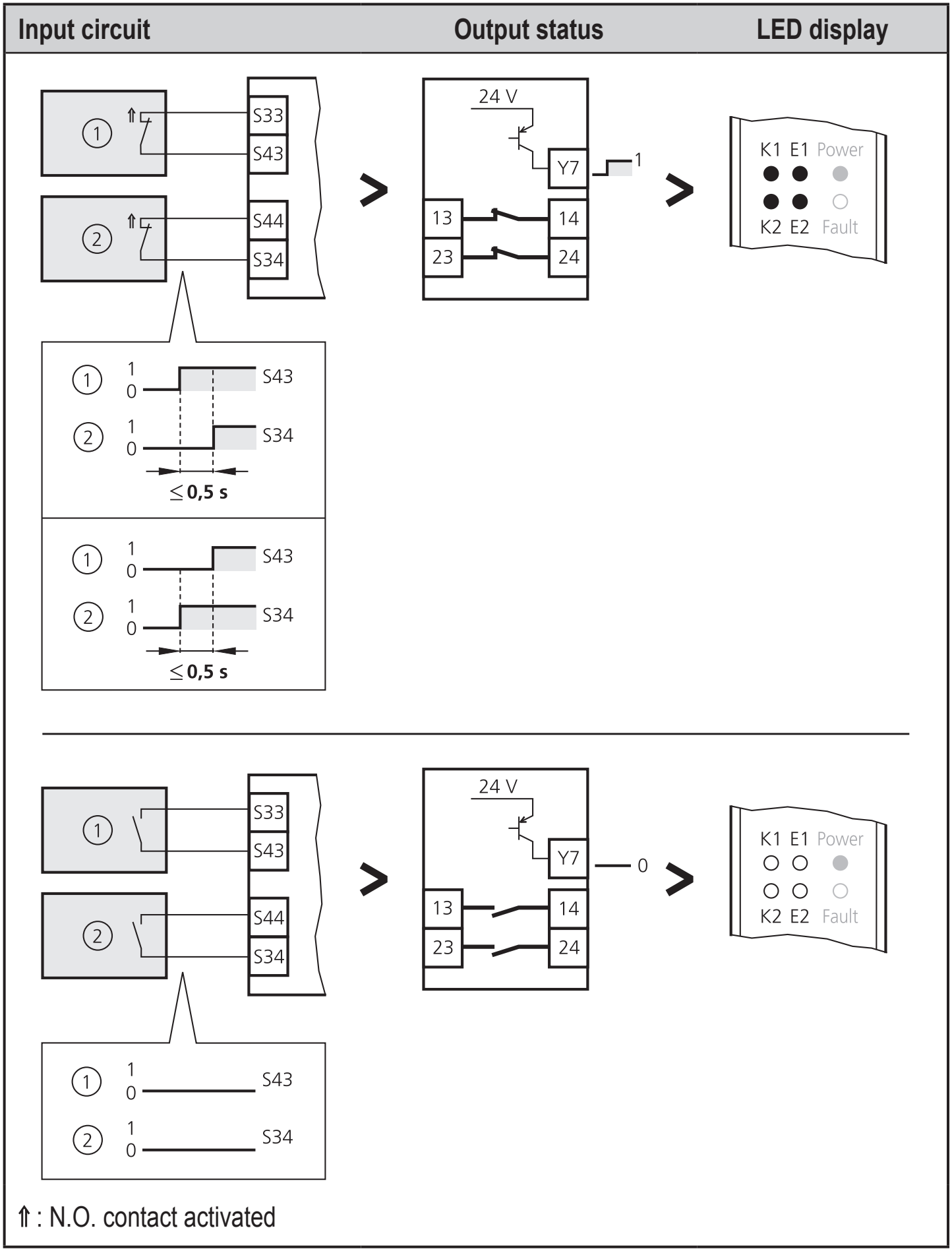
Connection of a 2-channel fail-safe sensor/switch
e.g. "electro-sensitive protective equipment" (ESPE) to EN 61496-1



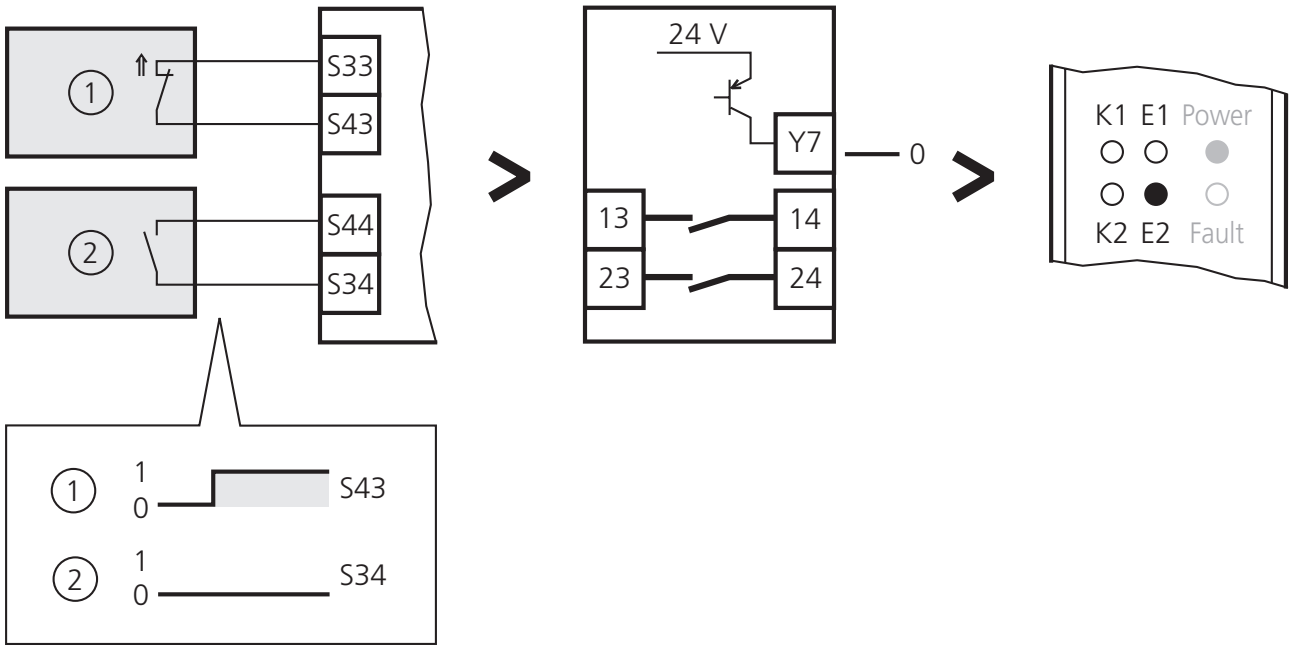
1: Contact 1 of the ESPE

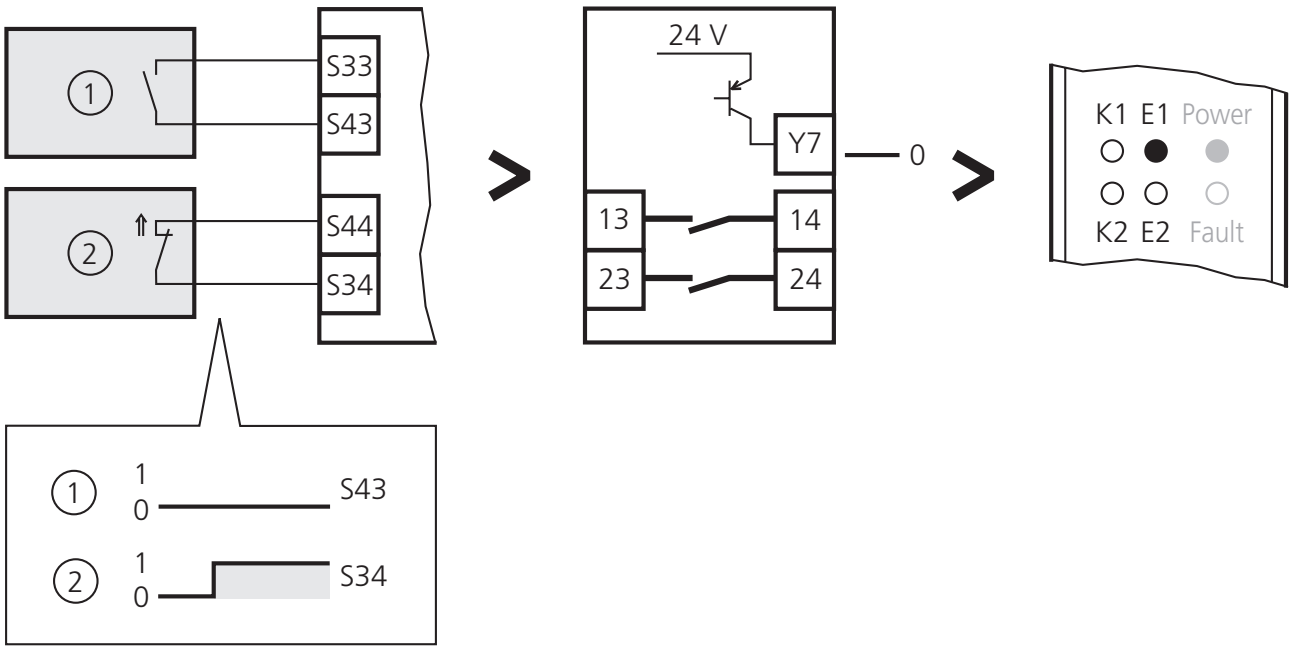
2: Contact 2 of the ESPE

8.4.2 Function



Input circuit	Output status	LED display



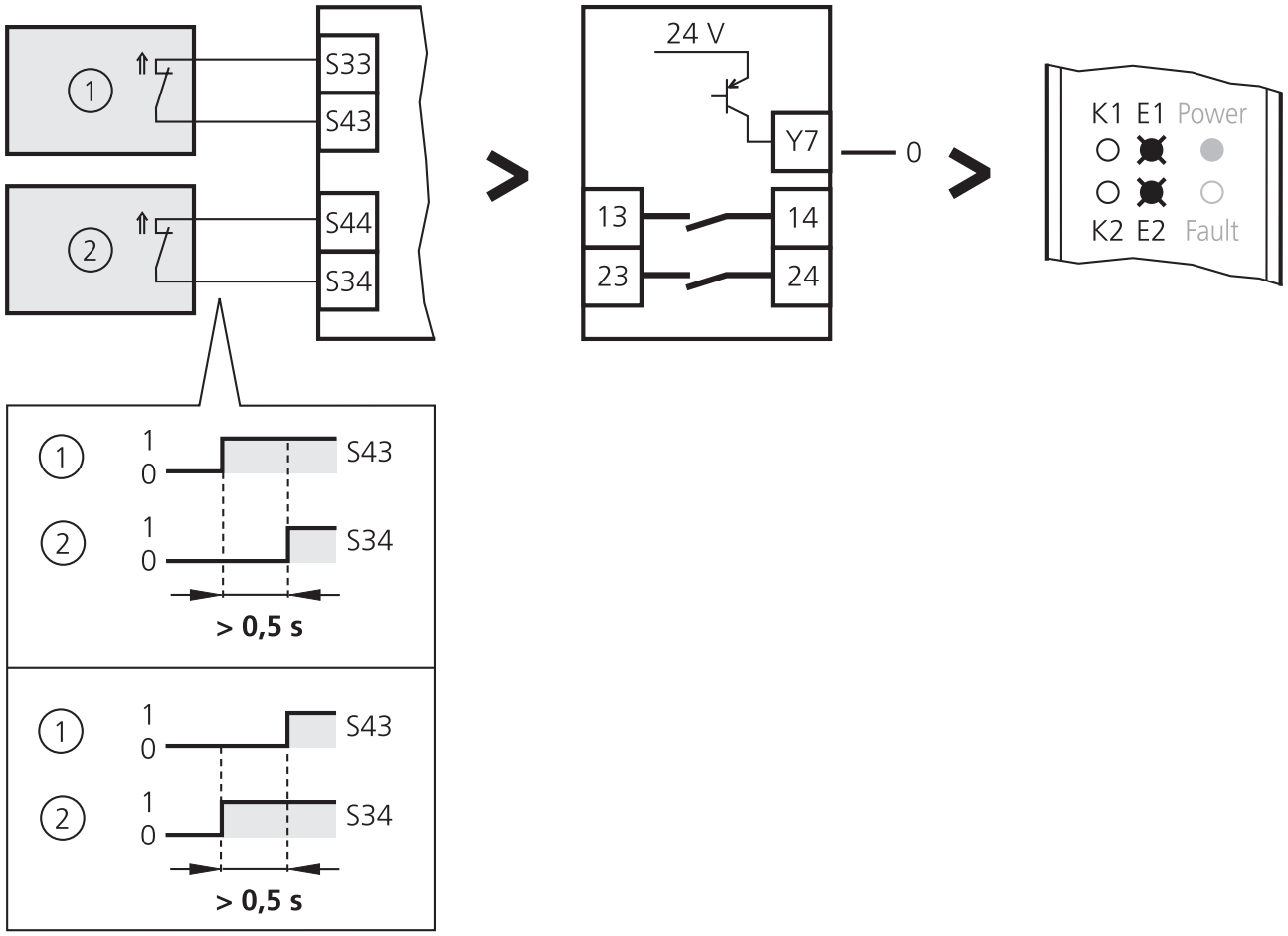


1: Electronic fail-safe sensor 1

2: Electronic fail-safe sensor 1

UK

Input circuit	Output status	LED display



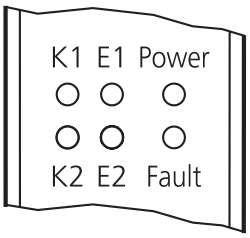
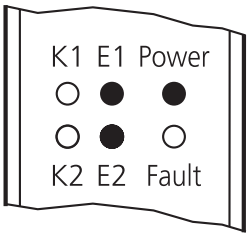
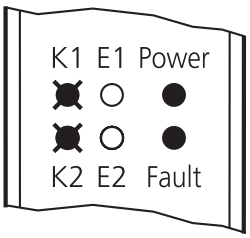
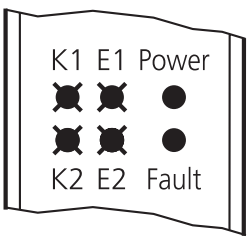
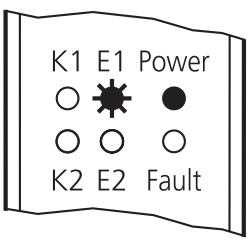
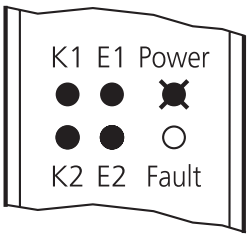
1: Electronic fail-safe sensor 1

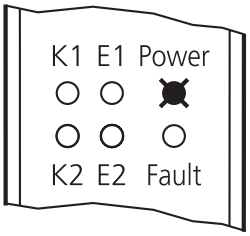
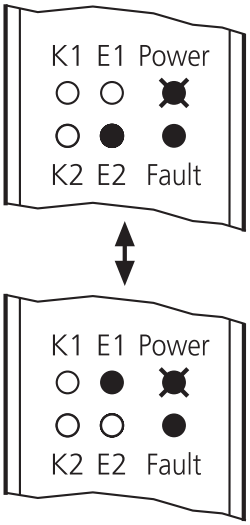
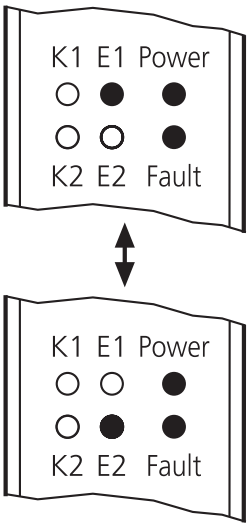
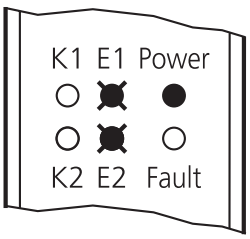
2: Electronic fail-safe sensor 2

⇑ : N.O. contact activated

8.4.3 Fault diagnosis

In case of a fault switch the safety relay off and on again!

LED display	Cause of the fault	Troubleshooting
	• No voltage supply • Overvoltage • Connection A1/A3 or A1/A2 reversed	▶ Check wiring ▶ Check power supply
	• Wire break • Feedback contacts open • Time-dependent contacts	▶ Check wiring ▶ Switch the safety relay off and on again
	• When voltage is applied: Feedback contacts open	▶ Check output circuit ▶ Check feedback contacts ▶ Exchange external contactor
	• Wiring fault • Missing link Y4/Y5 • Short circuit • Contacts closed when voltage is applied	▶ Check wiring ▶ Open contacts and RESET or voltage failure
	• Connection A2/A3 reversed	▶ Check wiring
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply

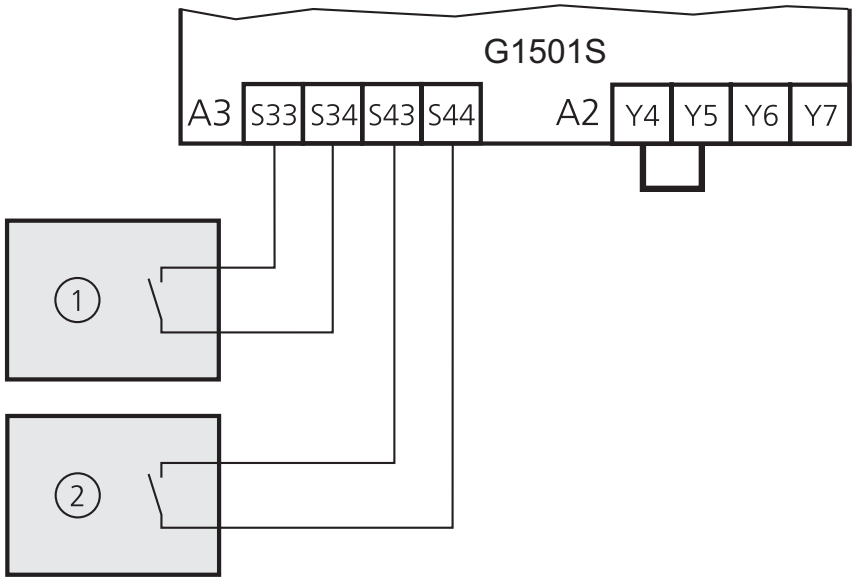
LED display	Cause of the fault	Troubleshooting
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Undervoltage	▶ Check wiring ▶ Check power supply
	• Short circuits	▶ Check wiring
	• Inputs S34 and S43 not activated within 0.5 s (→ 8.4.2) • Feedback contact error • Short circuit S34/S44	▶ Check wiring ▶ Deactivate inputs and activate them again

8.5 Safety relay for mechanical switches or 2-channel fail-safe sensors/switches with contact output and without simultaneity monitoring

The 2-channel fail-safe sensors/switches are for example "electro-sensitive protective equipment" (ESPE) to EN 61496-1.

The contacts of the sensors/switches must allow a minimum current of 6 mA.

8.5.1 Connection

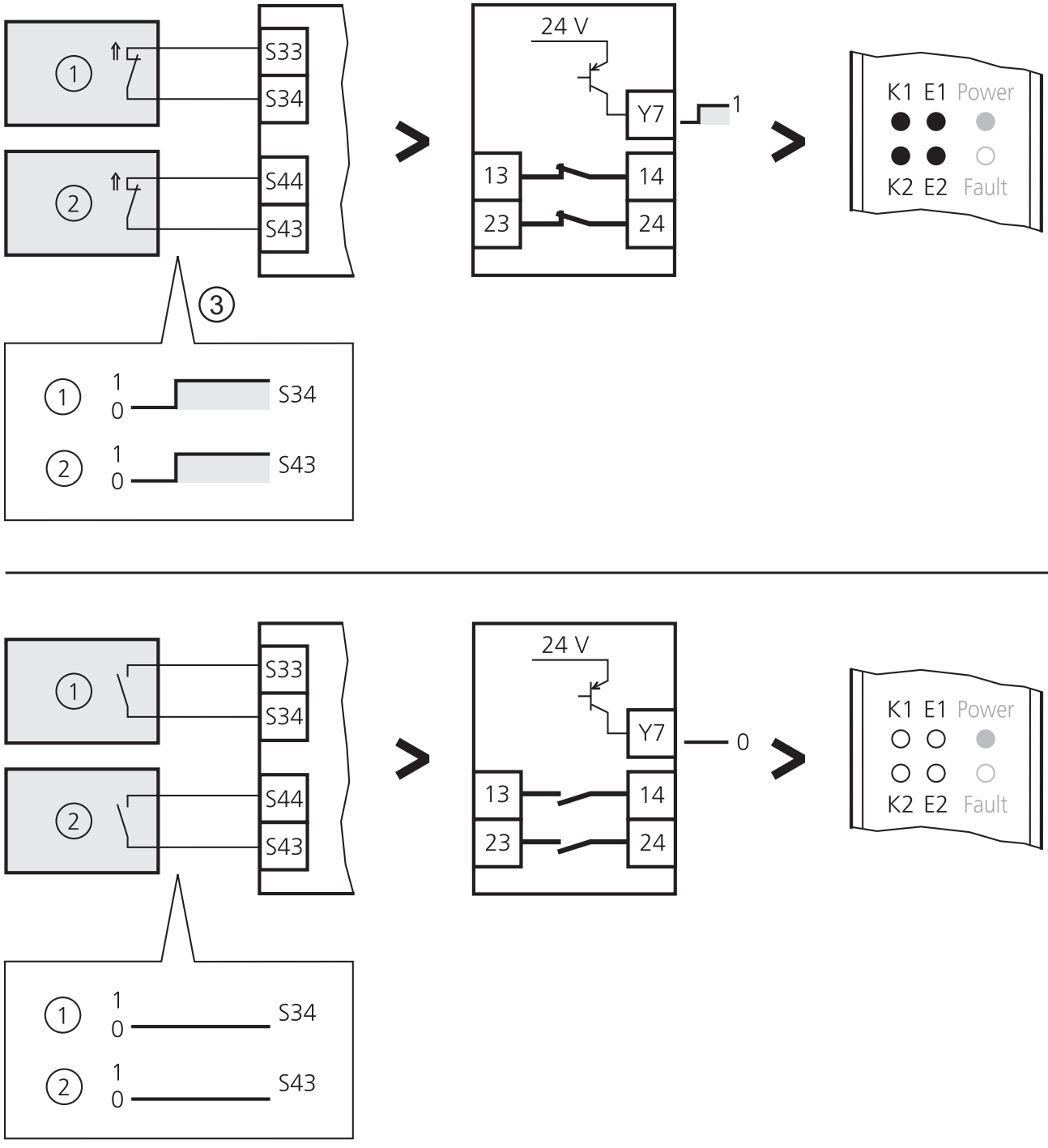


1: Mechanical switch 1

2: Mechanical switch 2

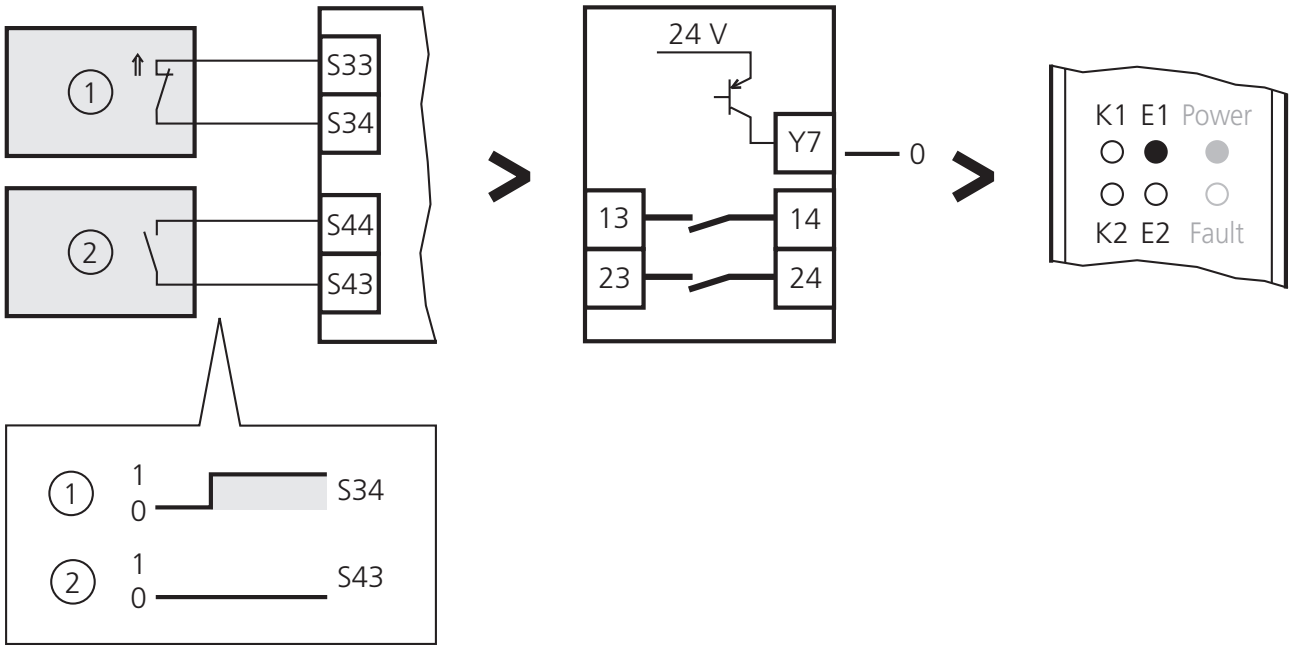
8.5.2 Function

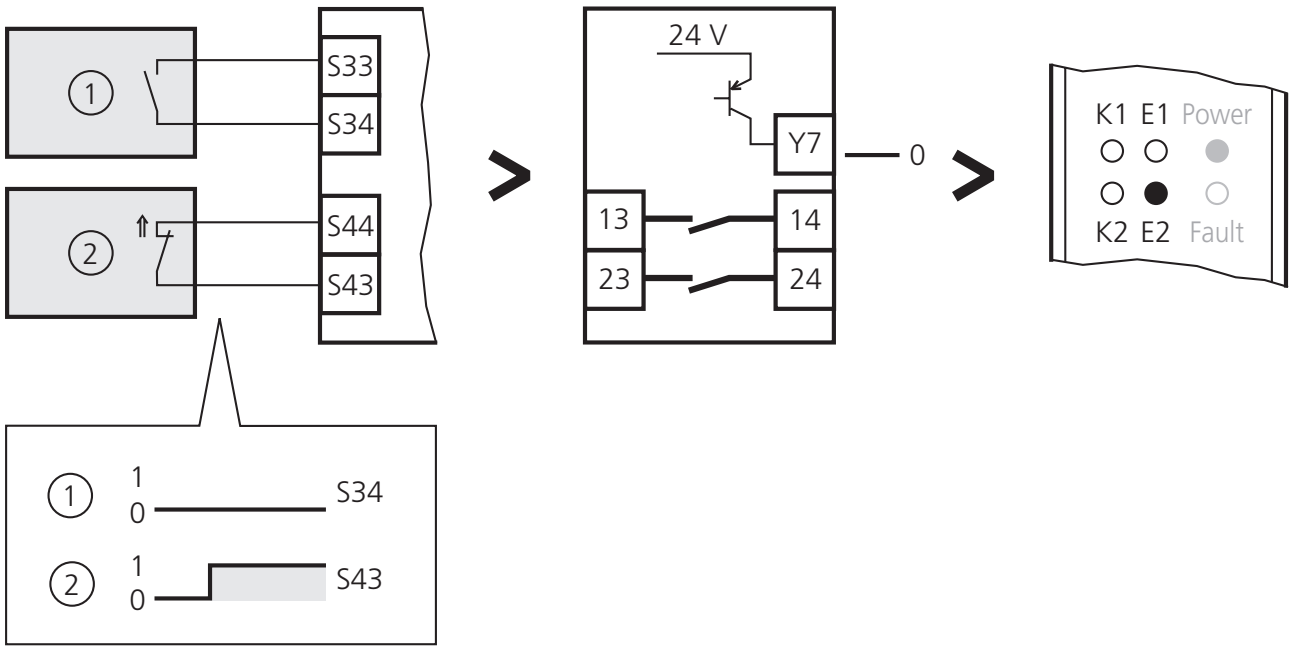
Input circuit	Output status	LED display



1: Fail-safe sensor/switch 1
2: Fail-safe sensor/switch 2
3: Order and time difference insignificant (indefinite simultaneity)
⇑ : N.O. contact activated

Input circuit	Output status	LED display



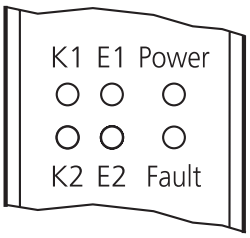
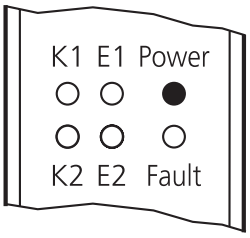
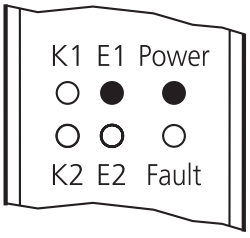
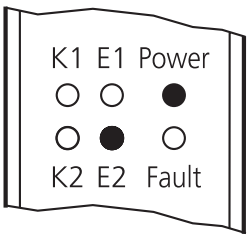
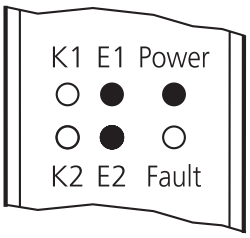
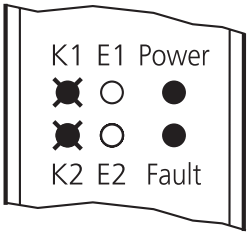


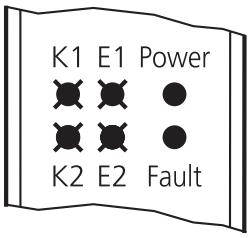
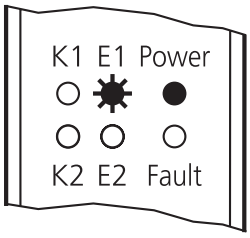
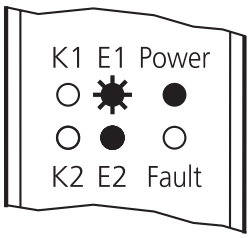
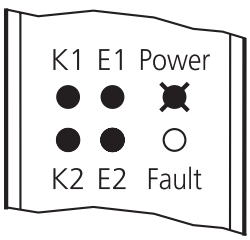
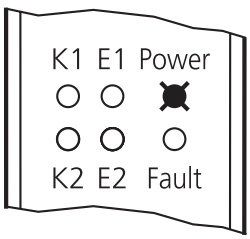
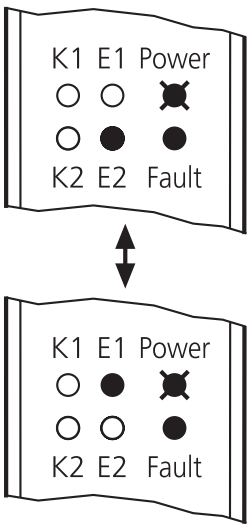
1: Fail-safe sensor/switch 1
2: Fail-safe sensor/switch 2
⇑ : N.O. contact activated

UK

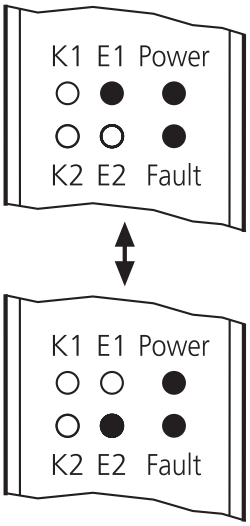
8.5.3 Fault diagnosis

In case of a fault switch the safety relay off and on again!

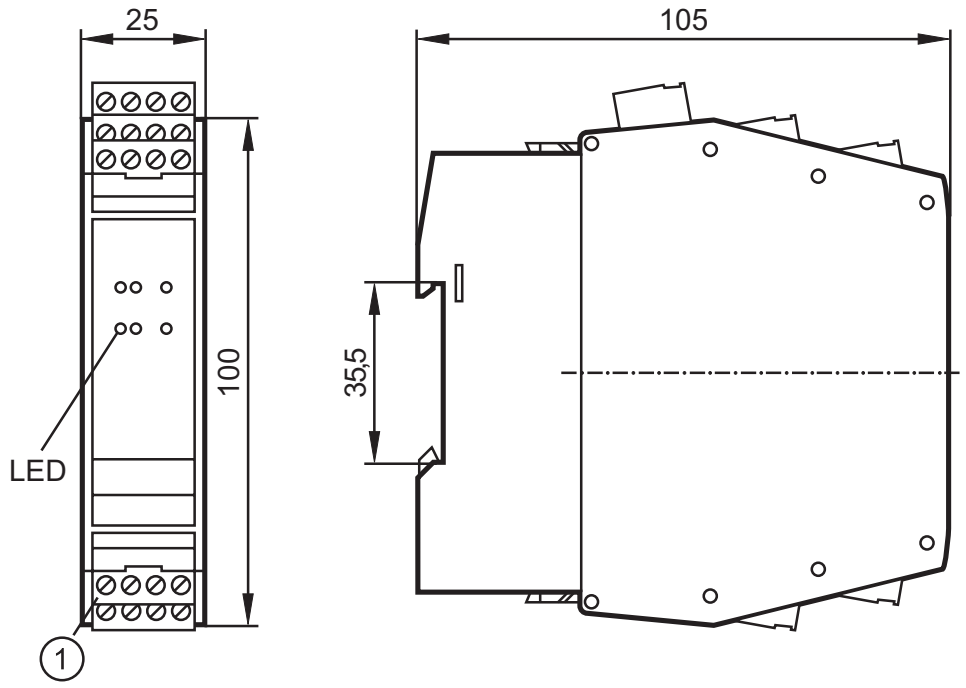
LED display	Cause of the fault	Troubleshooting
	• No voltage supply • Overvoltage	▶ Check wiring ▶ Check power supply
	• Short circuit • Wire break	▶ Check wiring
	• Short circuit • Wire break	▶ Check wiring
	• Short circuit • Wire break	▶ Check wiring
	• Feedback contacts open • Wire break	▶ Check wiring
	• When voltage is applied: Feedback contacts open	▶ Check output circuit ▶ Check feedback contacts ▶ Exchange external contactor

LED display	Cause of the fault	Troubleshooting
	• Wiring fault • Missing link Y4/Y5 • Short circuit	▶ Check wiring
	• Connection A2/A3 reversed	▶ Check wiring
	• Missing link Y4/Y5	▶ Check wiring
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Overvoltage • Undervoltage	▶ Check wiring ▶ Check power supply
	• Undervoltage	▶ Check wiring ▶ Check power supply

UK

LED display	Cause of the fault	Troubleshooting
	• Short circuits	▶ Check wiring

9 Scale drawing



1: Combicon connector with screw terminals (supplied)

10 Technical data

G1501S

Safety relay with relay outputs

Terminal block Phoenix Contact MSTBO

Meets the requirements of:
EN ISO 13849-1: 2008 category 4 PL e, SIL 3 (IEC 61508), type IIIC (EN 574)

Electrical design	Relay
Output function	2 safety-related NO (floating contacts) 1 signal output (positive switching)
Operating voltage	24 V DC (19.2...30) incl. 5 % residual ripple
Contact rating	6 A, 250 V AC / 24 V DC (min 6 mA)
Short-circuit protection / overload protection	The contacts are to be protected by means of fuses with a nominal current of < 3.6 A
Current consumption	< 200 mA
Function display	voltage (green), error (red), output status (2 x yellow), input (2 x yellow)

Power-on delay time	< 6 s				
Response time [ms]	acc. to input circuit → chapter				
	8.1	8.2	8.3	8.4	8.5
Release	40	160	40	110	110
Safety requirement	30	180	30	30	30
Ambient temperature	-25...55°C				
Protection rating	IP 20				
Housing materials	PA				
Input characteristics (S34, S43)	"1": > 11 V, 6 mA "0": < 5 V, < 500 µA				
Output characteristics	S33 push-pull short-circuit proof "0": I_{sink} ~ 30 mA "1": I_{source} ≥ 50 mA, U > 18 V S44 "0": I_R ≤ 300 µA "1": I_{source} ≥ 50 mA, U > 18 V Y7 "0": I_R ≤ 300 µA "1": I_{source} ≥ 11 V @ 30 mA, ≥ 15 V @ 15 mA				
Current through feedback contacts (Y1-Y2 or Y1-Y6)	6 mA				
Mission time T_M (Mission time)	175 200 h				
Safety-related reliability PFH	2.2 x 10^{-9} / h				
$MTTF_D$	136 years				
DC / CCF / Cat.	99 % / 80 % / 4				
$B10_D$	max. 780 000				
Comments	Additional comments concerning the cULus approval (UL 508): • Maximum ambient temperature 55°C (in the control cabinet) • The safety functions were not assessed by UL. The approval has been made according to UL 508 for general applications. • Use 60/75°C copper conductors only. • For use in pollution degree 2 environment • Same polarity (phase) referred to the output contacts				

11 Tests/approvals

The safety relay G1501S was tested and certified by TÜV-Nord.

The safety relay was developed and tested in accordance with the following directives and standards:

- 2006/42/EC Machinery Directive
- 2004/108/EC EMC Directive
- 73/23/EEC or 93/68 Low voltage directive
- DIN EN 954-1 (1996) category 4, safety of machinery, safety-related parts of control systems (valid until 31 December 2011)
- EN ISO 13849-1: 2008 category 4 PL e, safety of machinery, safety-related parts of control systems
- DIN EN 60204-1: (1997) (where applicable) Electrical equipment of machines

- DIN EN 574 type IIIC: Safety of Machinery - Two-Hand Control Devices - Functional Aspects – Principles for Design
- IEC 61508: (2000-2003): Functional safety of electrical/electronic/ programmable electronic safety-related systems
- UL 508

12 Terms and abbreviations

ESPE		Electro-Sensitive Protective Equipment.
Cat.	Category	Category Classification of the safety-related parts of a controller as regards their resistance to failures.
CCF	Common Cause Failure	Common cause failure.
DC	Diagnostic Coverage	Diagnostic coverage.
MTTF	Mean Time to Failure	Mean time to failure.
$MTTF_D$	Mean Time To Dangerous Failure	Mean time to dangerous failure.
OSSD	Output Signal Switching Device	Switching output triggering the safety circuit
PFH (PFH_D)	Probability of (dangerous) Failure per Hour	Probability of a (dangerous) failure per hour.
PL	Performance Level	PL to EN ISO 13849-1
SIL	Safety Integrity Level	SIL 1-4 to IEC 61508
PLC		Programmable Logic Controller

Technical data and further information at

www.ifm.com